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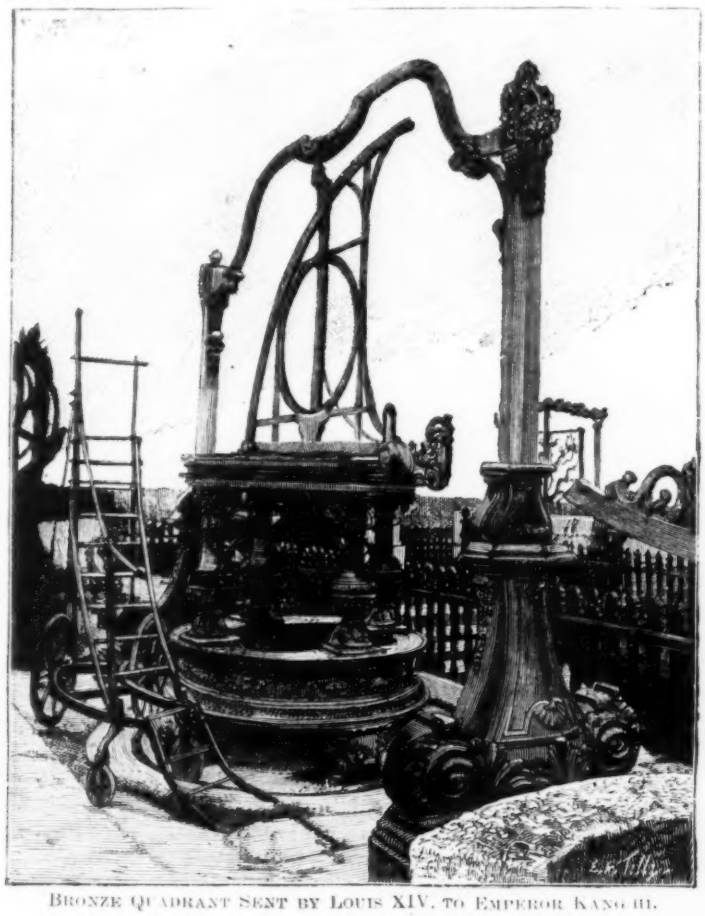
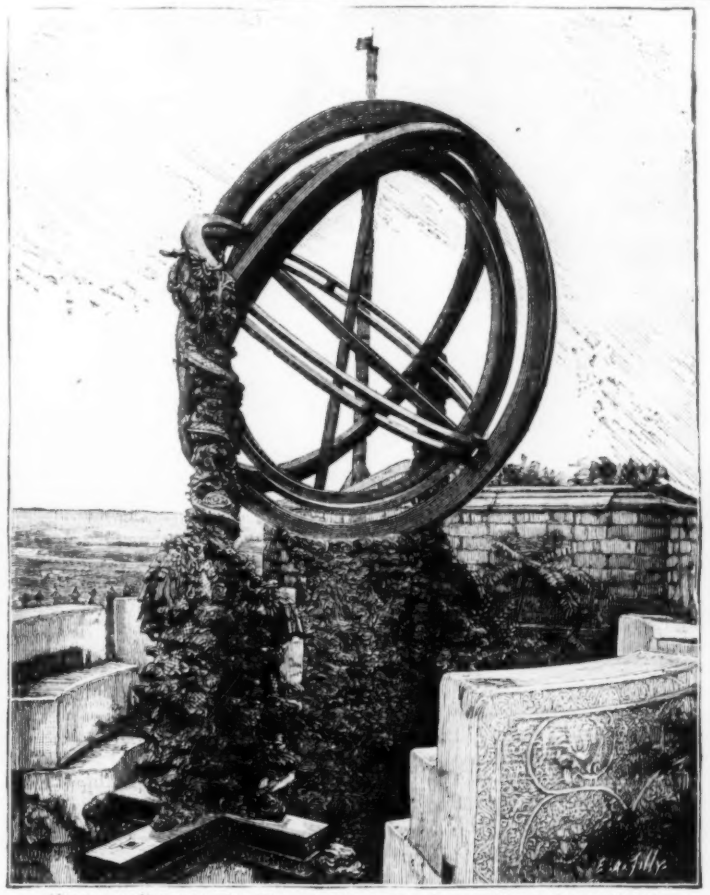
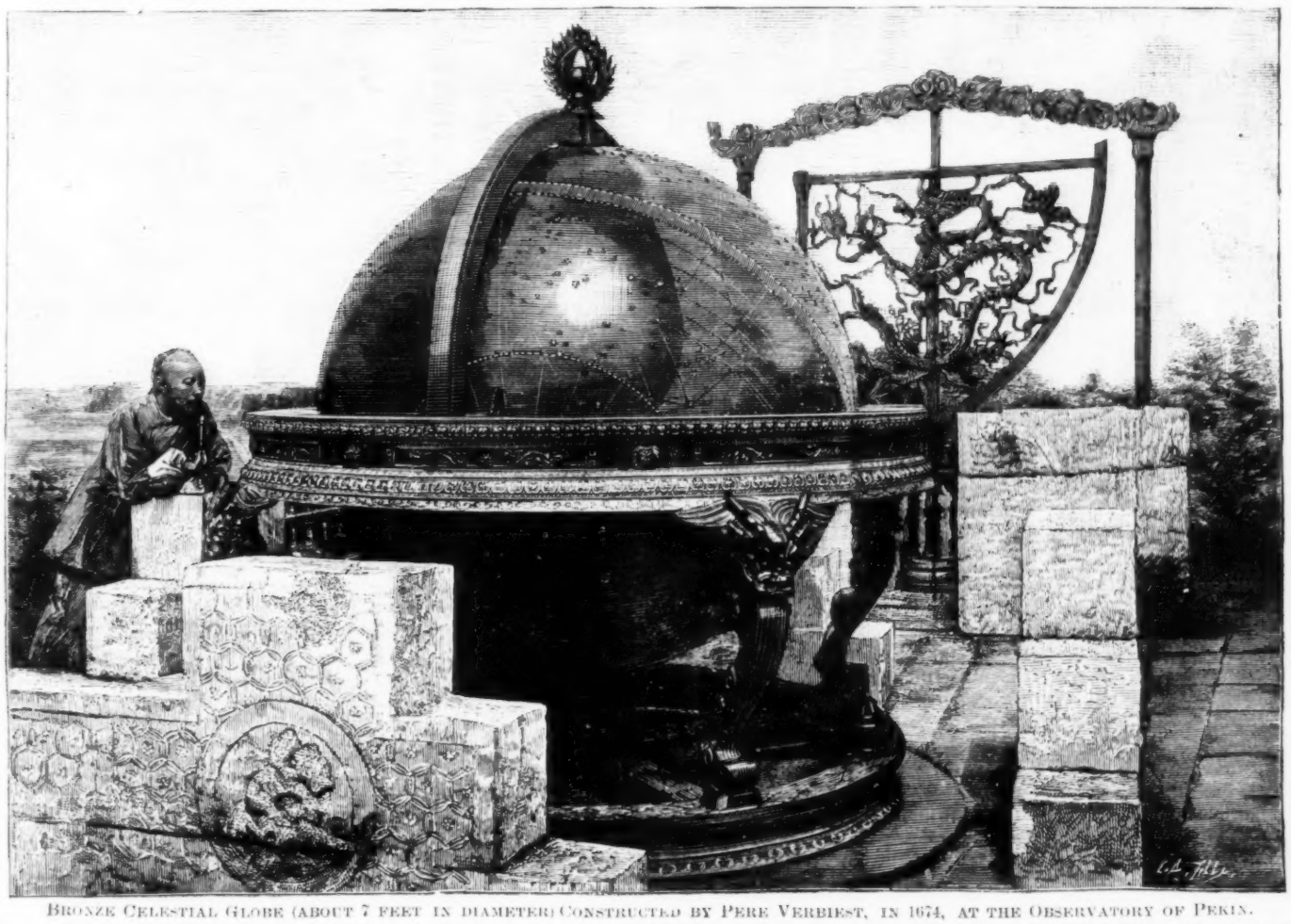


BRONZE QUADRANT SENT BY LOUIS XIV. TO EMPEROR KANG HI.



CHINESE BRONZE ARMILLARY SPHERE (SEVENTEENTH CENTURY).



BRONZE CELESTIAL GLOBE (ABOUT 7 FEET IN DIAMETER) CONSTRUCTED BY PERE VERBIEST, IN 1674, AT THE OBSERVATORY OF PEKIN.

THE ASTRONOMICAL INSTRUMENTS AT THE OBSERVATORY OF PEKIN, SEIZED BY THE GERMAN AND FRENCH GOVERNMENTS.

THE LOOTING OF THE PEKIN OBSERVATORY.

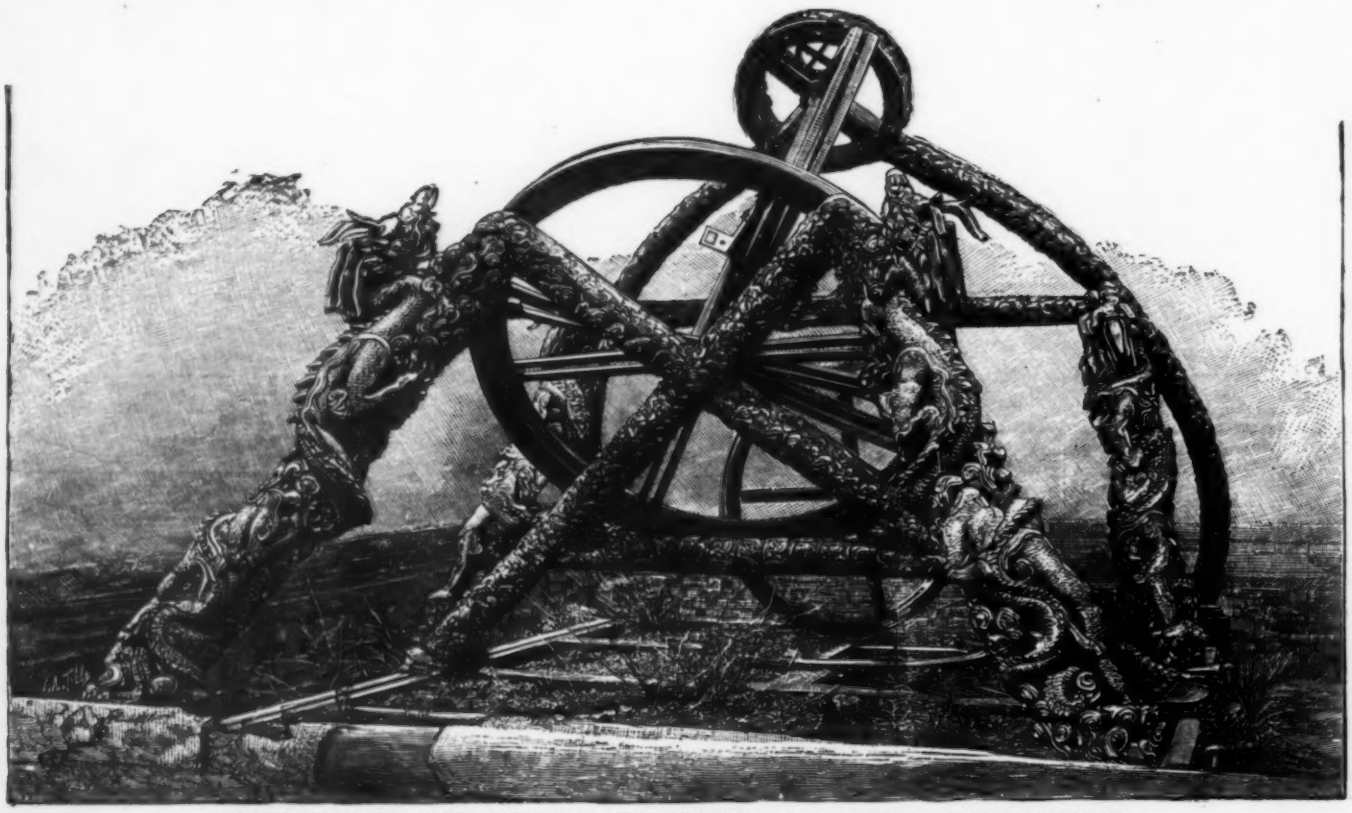
THE scientific world has been shocked at the looting of the Pekin Observatory by the French and German troops. The instruments are to be sent to Europe. It is greatly to General Chaffee's credit that he protested vigorously against this very unwarrantable act of vandalism. At the end of this century, institutions like an observatory should at least be held sacred by civilized combatants. Our engravings represent a bronze sphere and a celestial globe of the same material, nearly seven feet in diameter, constructed under the direction of Father Verbiest, in the seventeenth century. Our first engraving represents a bronze quarter-circle sent by Louis XIV. to the Emperor Kang-Hi in the seventeenth century. Our fourth engraving represents the chief piece of this observatory, so rich in artistic wonders. It is a bronze astronomical instrument vaguely recalling an equatorial. It was constructed in the thirteenth century by Ko-Chon-King, astronomer of the emperor of the first Tatar dynasty and the founder of Pekin. The fifth engraving gives a general view of the astronomical instruments installed upon the terrace of the observatory by Father Verbiest while he was president of the tribunal of mathematics in 1674. Up to the present, nothing has been changed in the arrangement of these apparatus, and they stand now just as they were placed by the learned missionary two hundred years ago.

The general view of the Pekin Observatory, established at the beginning of the nineteenth century near the Tatar rampart and the Temple of the Lettered, has a feudal character which more closely recalls the old gates with elliptic arches of the fortified cities of the middle ages than the original structures of the extreme East. It is a massive square tower, of medium height, at the top of which is observed a series of odd silhouettes. These latter are those of the instruments shown in one of our drawings. A little lower, from the left of the tower, starts a sort of shed with curved roof, and very Chinese, under which have rested, since the foundation of Pekin, a few Mongolian instruments which are genuine artistic marvels, that our engraving can scarcely give any idea of.

This observatory is, or rather was, one of the rare curiosities of the capital of the Celestial Empire.

According to those who have studied them, the accuracy of the instruments is questionable; the Chinese artisans charged with the graduation not having reproduced with exactness the models given to them.

Nowhere is there met a trace of a telescope or even of a simple tube capable of concentrating the visual rays of the observer upon a single point. The pinnule is alone employed for observations. Fortunately for science, alongside of this official observatory, the Cluny Museum of Chinese astronomy, stand some establishments, such as Lika Wey, in which are found the most improved models of contemporary optics.—For our engravings we are indebted to L'Illustration.



CHINESE BRONZE ASTRONOMICAL INSTRUMENT OF THE THIRTEENTH CENTURY.

RECENT DISCOVERIES IN CRETE.

THE interference of the Powers for the pacification of Crete is already sufficiently rewarded by the wonderful revelation which has just been made of the history of the early days of civilization. The story which is told this week of the work of exploration during the past season on the site of ancient cities and palaces constitutes the most fascinating and valuable contribution to archæological knowledge of recent years.

It needs no training in archæology to appreciate the value and interest of the revelations made by the uncovering of the ancient "House of Minos," which had lain hidden for more than 3,000 years. Some of the most familiar legends of mythology are being transmitted into recorded history and the process may well command the attention of men and women of all classes and of all countries.

The sites assigned for British exploration have thus far yielded the best results and the report given to the public by A. J. Evans and D. G. Hogarth is a most fascinating document which every reader can understand and appreciate. All its essential features are included in the following extracts:

"The discoveries made at Knossos throw into the shade all the other exploratory campaigns of last season in the eastern Mediterranean by whatever nationality conducted. It is not too much to say that the materials already gathered have revolutionized our knowledge of prehistoric Greece, and that to find even an approach to the results obtained we must go back to Schliemann's great discovery of the royal tombs at Mycenæ.

"The prehistoric site, of which some two acres have now been uncovered at Knossos, proves to contain a palace beside which those of Tiryns and Mycenæ sink into insignificance. By an unhoped-for piece of good fortune, the site, though in the immediate neighborhood of the greatest civic centers of the island in ancient, medieval, and modern times, had remained practically untouched for over 3,000 years. At but a very slight depth below the surface of the ground the spade has uncovered great courts and corridors, propylæa, a long succession of magazines containing gigantic stone jars that might have hidden the 'Forty Thieves,' and a multiplicity of chambers, pre-eminent among which is the throne room and council chamber of Homeric kings.

"The throne itself on which (if so much faith be permitted to us) Minos may have declared the law, is carved out of alabaster, once brilliant with colored designs and relieved with curious tracery and crocketed arcading which is wholly unique in ancient art and exhibits a strange anticipation of thirteenth century Gothic. In the throne room, the western entrance gallery and elsewhere, partly still adhering to the walls, partly in detached pieces on the floors, was a series of fresco paintings, excelling any known examples of the art in Mycenæan Greece.

"A beautiful life-size painting of a youth, with a European and almost classically Greek profile, gives us the first real knowledge of the race who produced this mysterious early civilization. Other frescoes introduce us to a lively and hitherto unknown miniature style, representing, among other subjects, groups of women engaged in animated conversation in the courts and on the balconies of the palace. The monuments of the sculptor's art are equally striking. It may be sufficient to mention here a marble fountain in the shape of a lioness' head with enameled eyes, fragments of a frieze with beautifully cut rosettes, superior in its kind to anything known from Mycenæ; an alabaster vase naturally copied from a Triton shell; a porphyry lamp with graceful foliation, supported on an Egyptianizing lotus column. The head and parts of the body of a magnificent painted relief of a bull in gesso duro are unsurpassed for vitality and strength.

"It is impossible here to refer more than incidentally to the new evidence of intercourse between Crete and Egypt at a very remote period supplied by the palace finds of Knossos. It may be mentioned, however, as showing the extreme antiquity of the earlier elements of the building that in the great eastern court was found an Egyptian seated figure of diorite, broken above, which can be approximately dated about 2000 B. C. Below this again extends a vast Stone Age settlement which forms a deposit in some places 24 feet in thickness.

"Neither is it possible here to dwell on the new indications supplied by some of the discoveries in the 'House of Minos' as to the cult and religious beliefs of its occupants. It must be sufficient to observe that one of the miniature frescoes found represents the facade of a Mycenæan shrine and that the palace itself seems to have been a sanctuary of the Cretan God of the Double Ax, as well as a dwelling place of prehistoric kings. There can be little remaining doubt that this huge building with its maze of corridors and tortuous passages, its medley of small chambers, its long succession of magazines with their blind endings, was in fact the Labyrinth of later tradition which supplied a local habitation for the Minotaur of grisly fame.

"The great figures of bulls in fresco and relief that adorned the walls, the harem scenes of some of the frescoes, the cornerstones and pillars marked with the labrys or double ax—the emblem of the Cretan Zeus, explaining the derivation of the name 'Labyrinth' itself—are so many details which all conspire to bear out this identification. In the palace shrine of Knossos there stands at last revealed to us the spacious structure which the skill of Dædalus is said to have imitated from the great Egyptian building on the shore of Lake Mœris, and with it some part at least of his fabled masterpieces still clinging to the walls.

"But brilliant as are the illustrations thus recovered of the high early civilization of the city of Minos and of the substantial truth of early tradition, they are almost thrown into the shade by a discovery which carries back the existence of written documents in the Hellenic lands some seven centuries beyond the first known monuments of the historic Greek writing. In the chambers and magazines of the palace there came to light a series of deposits of clay tablets, in form somewhat analogous to the Babylonian, but inscribed with characters in two distinct types of indigenous prehistoric script—one hieroglyphic or quasi-pictorial, the other linear. The existence of a hieroglyphic script in the island had been already the theme of some earlier researches by the explorer of the palace, based on the more limited material supplied by groups of signs on a class of Cretan seal stones, and the ample corroboration of the conclusions arrived at was, therefore, the more satisfactory. These Cretan hieroglyphs will be found to have a special importance in their bearing on the origin of the Phœnician alphabet.

"But the great bulk of the tablets belonged to the linear class, exhibiting an elegant and much more highly-developed form of script, with letters of an upright and singularly European aspect. The inscriptions, over 1,000 of which were collected, were originally contained in coffers of clay, wood and gypsum, which had been in turn secured by clay seals impressed with finely engraved signets and countermarked and countersigned by controlling officials in the same script while the clay was still wet. The clay documents themselves are, beyond doubt, the palace archives. Many relate to accounts concerning the Royal Arsenal, stores and treasures. Others, perhaps, like the contemporary cuneiform tablets, refer to contracts or correspondence. The problems attaching to the decipherment of these clay records are of enthralling interest, and we have here locked up for us materials which may some day enlarge the bounds of history.

"The work of excavation in the Palace of Knossos is barely half completed, and yet whichever way we turn the relics already obtained from within its walls supply new and unhoped-for data for the reconstruction of early Ægean civilization. Nor is this all. Exploratory digging to the south and west of the palace revealed a veritable Pompeii of houses of the same early period, which yielded among other things by far the finest series yet found of vases of the singular primitive Cretan polychrome style, unrepresented in European museums. One remarkably well preserved block of buildings appears to be a group of shrines devoted to a pillar worship, such as is known on the Phœnician and Palestinian coasts, and of which the palace itself supplies an example connected with the cult of the Cretan Zeus.

"Finally in the early heats the clearing of the Cave of Psychro, notorious since some years for its rich

votive deposits, was carried out. This cave is no other than the holy Dictæan Cavern in which Hesiod and Virgil state that the Supreme God was cradled. There took place the legendary union of Zeus with Europa, and therefrom, as from another Sinai, Minos brought down the law after communion with the god. The blasting away of the fallen rocks in the upper half of the grotto revealed a rude altar of burnt sacrifice and a sacred inclosure or Temenos, cumbered with the votive deposits from five to seven feet deep, full of vases, libation tables, weapons and implements in bronze, bone and iron, statuettes in terra cotta and models of everyday objects, dedicated to the god.

"In the lower half opens a profound abyss, where a gloomy subterranean pool, out of which rises a forest of stalactitic pillars, continues into the heart of the mountain. Here a great surprise was in store. For not only was the bottom mud full of bronze statuettes, gems and articles of male and female use, but the vertical slits in the pillars were found to have been used as niches and to contain an immense number of votive double axes, weapons and trinkets. This vast cavern was undoubtedly the mysterious Holy of Holies into which Minos descended alone, and on emerging, as Dionysius says, showed the law to the people as a gift from Zeus himself. The discoveries made in this cave cover the whole primitive period of Cretan history back to the pre-Mycenæan epoch.

"The Palace of Knossos is still but half uncovered, and the large expenditure entailed by excavation of this vast building, which its explorer hopes to take up again in February next, is a severe strain on individual resources. Among the other sites included in the British concession are two Votive Caves, the citadels of more than one Mycenæan city of eastern Crete, and Præsos, the ancient capital of that region, within whose walls the language of the old indigenous stock—the Eteokretes of the Odyssey—survived to historic times. Here, if anywhere, should be found the key to the undeciphered hieroglyphic script of Crete, and it is to be hoped that sufficient funds may be forthcoming to begin excavation at this spot during the coming season under the auspices of the British School at Athens.

"The exploration that we have taken in hand is not one confined to the backwaters of antiquarian research. It lies about the fountain-head of our own civilization. Inadequately supported as it has been, it has already produced results which throw an entirely new light on the first development of high art, the origin of letters, the early religion and ethnography of the Greek lands, the most ancient connection between Europe and Egypt."

LANDSCAPE GARDENING IN MAINTENANCE OF WAY WORK.*

By LOUVILLE CURTIS, Roadmaster, B. and M. R.R.

So much has been done in the past for the physical comfort of their patrons, it is natural that more attention from railroad officials should now be given to the embellishment of station grounds, and the neat and attractive appearance of the roadbed in general. What will do more to break the monotony of a long and tedious railway journey than the charming bits of landscape scenery that can be obtained at little expense by restoring as far as possible the natural beauty in places where it has been destroyed, and to create natural scenery by natural means and methods, which is the highest form of the landscape gardener's work? The principles of his art should be involved in the sloping of every bank, the grading of every knoll or hollow, and I might almost say, in the removal of every bowlder, for lines can be left stiff and formal or graceful and natural. The bowlder can often at much less expense be left where Nature placed it, and with the proper treatment, become an object of beauty. There is much beauty in an unsightly pile of earth, if placed in the right position, but it requires thought and skill to bring it out. No embellishment with trees, shrubs, hardy or bedding plants, will be effective unless the grading is properly done. Any mistake then made cannot be afterward corrected except at great expense.

The best architectural skill is employed to design convenient and attractive stations. The plans are carefully examined by railway officials and changes frequently made for convenience or outward appearance. The grading generally receives but little attention from any one. Sometimes it is not considered at all until the building is nearly completed. The public and all others interested are anxious to occupy the new station as soon as possible. The grading is done in a hurry, and often under the direction of a foreman who has had no training to fit him for that particular kind of work.

A plan of the grounds should be carefully prepared before the building is commenced. The location of trees, shrubs or bedding plants should be shown, the varieties to be used determined, and the grading done so as to give a proper depth of fertile soil where needed. On the thoroughness with which this work is done depends the success of all subsequent attempts to beautify the grounds. This method would be more economical, give better results, and do away with much of the haphazard work which we frequently see under the present system, or, more properly speaking, lack of system. The appearance of the station grounds is of quite as much importance to the public generally as the appearance of the station itself. Comparatively few people notice the interior of a building, where hundreds examine carefully the grounds around it. It is, therefore, important that this work should at least be done in such a manner as not to offend good taste.

The modern tendency of railroads is to adopt standards in everything. In these days of sharp competition it has been found necessary to secure uniformity as far as possible in every department. I think a large majority of railroads depart from this custom when they come to the ornamentation of station grounds. There seems to be almost an entire lack of uniformity in this work. I do not mean that the grounds of every station should receive the same treatment, for the treatment should conform to existing conditions, instead of attempting to adapt the existing conditions to the treatment. It would be just as absurd for the landscape gardener to adopt the same formal style for all station grounds, regardless of the surrounding or natural surface lines and grades, as for the physician to give the same treatment to every patient without considering his ailment, age or physical condition.

Personally, I dislike a too formal style. A well-kept lawn, with a proper arrangement of shrubs and other hardy plants, is always beautiful. Tender bedding plants produce a good effect for a few months. In the vicinity of Boston they cannot be safely put out until the early part of June. It is a month later before they are established, and early in September they are usually killed by frost. During the remaining months of the year there is nothing where they stood but unsightly piles of barren earth. Hardy shrubs, if properly selected, are ornamental every month in the year. Even in winter, when coated with ice or snow, they are especially effective. They also have the added merit of being less expensive if propagated by the railroads in their own nurseries, as they should be.

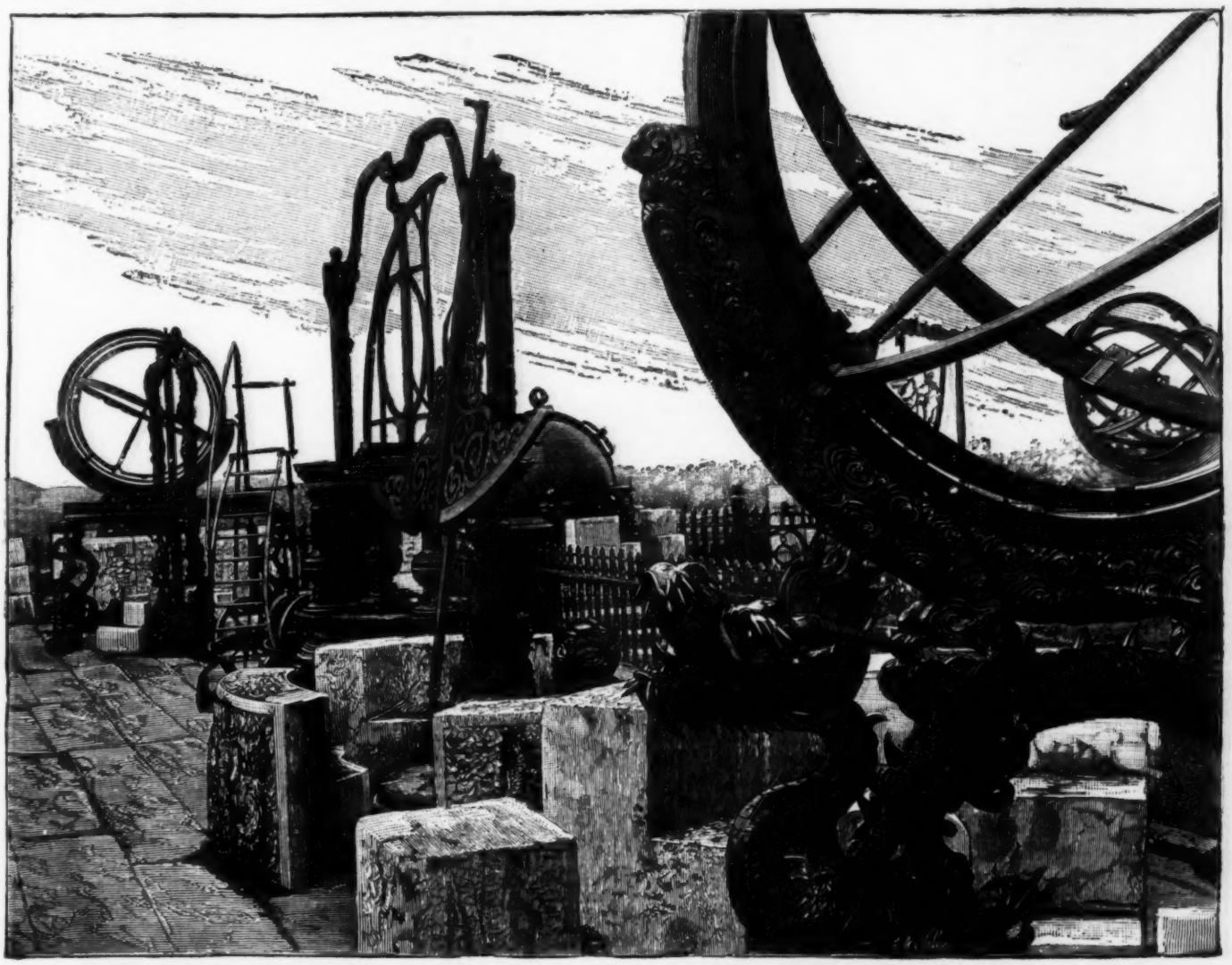
What I have said thus far applies more particularly to station grounds. The work of the landscape gardener should not stop here. All along the line the opportunities are many to improve the appearance of the entire area within the location. Banks should be properly sloped, depressions filled, large bowlders, where dangerous, removed; small ones buried or neatly piled, and all useless material disposed of in the cheapest manner possible. Unsightly walls, fences, large bowlders, etc., can at little expense be covered with ornamental vines. The Virginia creeper is excellent for this purpose. It is perfectly hardy, vigorous in growth, adapted to a great variety of soils, and is easily propagated. It is ornamental during its entire season of growth, particularly in the early autumn, when its leaves take on the most brilliant colors. The Boston ivy can be used with good effect to cover brick or stone walls adjacent to the tracks.

Railroad companies have a great opportunity to present a series of object lessons to the public, running, as they do, through such a variety of country; some thickly settled, most of it sparsely, through mountains, over hills, plains and swamps; adapted to such a variety of shrubs, trees and plants, that the landscape gardener has almost endless possibilities at his disposal. There are so many hardy native shrubs growing in large quantities at many points along the line of all important roads that the nurseryman need not be called upon to furnish the material needed.

I see no reason why hedges of barberry, California privet or honey locust should not be used in many localities instead of fences. If the shrubs were propagated by the railroad company, there would be but little expense for the stock, and the cost of planting would not be much greater than for building an ordinary fence. It would not only serve the ordinary purposes of a location fence, but in many places would prevent the snow drifting over the tracks in winter.

I am aware that the suggestions I have made are open to criticism on account of expense, but this ob-

* From a paper read before the eighteenth annual convention of the Eastern Maintenance of Way Association, Saratoga, N. Y., September 19, 1900.



GENERAL VIEW OF THE ANCIENT ASTRONOMICAL INSTRUMENTS AT THE CHINESE OBSERVATORY, PEKIN.

jection is more imaginary than real. I do not advise any radical changes in what has already been done, but think we should commence at once to work along the lines indicated. Much can be accomplished by section men late in the fall or early in the spring when there is but little track work that can be done. If only a small portion is completed each year, and that done properly, it would require but a few years to practically renovate the entire right of way, if each foreman would work in a systematic manner.

If under the direction of a competent foreman in sympathy with the work, the expense would hardly be noticed. I find it is easy to interest the average section foreman in this work. He needs encouragement and advice, but after he has once made a beginning, and has an opportunity to observe the improvements that are being made by his neighbors, the spirit of competition begins to develop, and its influence will soon be noticeable over the entire line. This sort of training serves a double purpose. It educates perception and develops thought. When men observe closely and think deeply, they are improving. When they do neither, they are in the ruts.

These suggestions have been offered from a layman's point of view, and not from that of a landscape gardener, for I make no claim to any technical knowledge of that art. During my experience in maintenance-of-way work I have found many foremen who are interested in beautifying portions of their sections, and some of them have done commendable work. They should at least receive our encouragement and assistance.

[Continued from SUPPLEMENT, No. 1306, page 20884.]

CLAY-WORKING MACHINERY AT THE PARIS EXPOSITION.

THE first of the illustrations (Fig. 26) shows a tile press by MM. Joly et Cie., of Blois. In this the top

FIG. 26.—TILE PRESS, BY MM. JOLY ET CIE., BLOIS.

for the manufacture of domestic pottery, such as plates, dishes, cups, saucers, etc.; these are generally of faience and porcelain. The only exhibit of this nature is that made by MM. Faure & Co., of Limoges, whose reputation for this class of machinery has long been established. The exhibit comprises a series of very interesting machines, some of which we illustrate. Only the machines for working the "paste" were omitted from the exhibit for want of space; but as these mills form a necessary unit of the series, we include an illustration of an approved type (Fig. 28). The operation of this machine will be understood from the engraving. It consists of a heavy frame carrying the table and the driving gear. The top of the table is inclined, as shown, from the center to the periphery; the gearing consists of a fast-and-loose pulley that drives a bevel pinion and spur mounted on a vertical shaft that passes through the table and carries a deep sleeve keyed on the end. On this sleeve are two sets of arms at right angles to each other. Upon one pair of arms are mounted two heavy coned rollers with fluted surfaces; on the other are two sets of adjustable rollers, the outer of each pair cylindrical, the inner coned; the distance between these can be varied by shifting their supports upon the arms. The operation of the machine is very simple; the clay and other materials previously prepared by the laborious processes of crushing, grinding, wet milling, etc., are placed on the table in suitable sizes and in a plastic condition. The vertical shaft is then caused to revolve, bringing the coned roller over the mass, which is kept in place by the four guiding rollers. This operation is continued until the "paste" has been sufficiently worked for the manufacturing processes.

The machines exhibited are those specially adapted for the production of practically flat ware, such as plates and dishes; and those for making hollow ware, such as cups, basins, etc. The former constitutes a series of three machines. The first of the set, illustrated

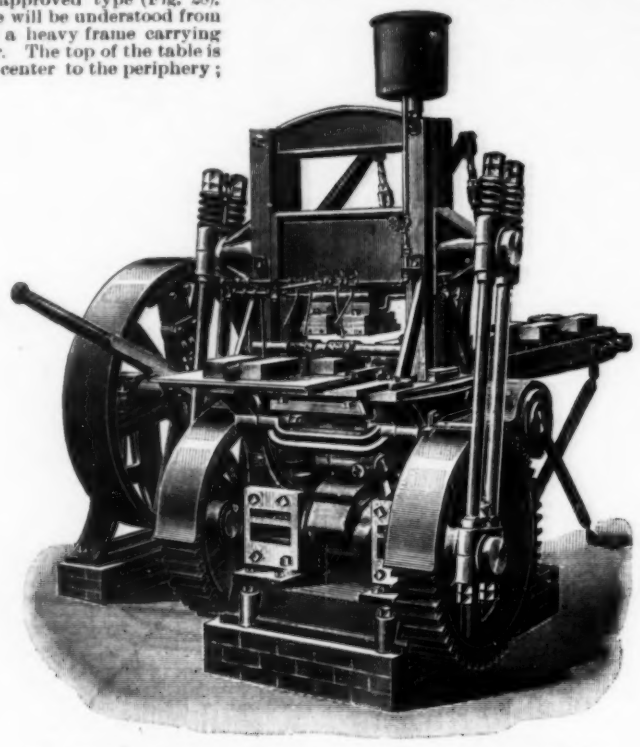


FIG. 27.—BRICK PRESS CONSTRUCTED BY THE AMERICAN CLAY-WORKING MACHINERY COMPANY, BUCYRUS, OHIO, U. S. A.

uniform thickness; as soon as this is complete, the vertical arm rises suddenly, the operator removes the blank and places another ball of paste on the revolving table. As already said, the whole work is automatic, except putting the paste on the table and removing the blanks, and the process is a very rapid one. It should be mentioned that the consistency of the paste is such that it can be freely handled without danger of being broken or deformed; to bring the clay to this condition is one of the essentials of the potter's art. The circular blank is now placed on the second machine of the series (Fig. 30). This, as will be seen from the illustration, is practically a press in which the rough form of the object is transferred to the blank. The third machine of the series, Fig. 31, completes the operation. This is a calibrating machine, and consists of a stand carrying a revolving table, and an adjustable arm, to which is attached a template or contouring blade. As the table revolves with the stamped plate laid upon it, the contouring blade removes all superfluous clay, and finishes the outside surface, the inner face having been finished in the preceding machine. Obviously, these machines as illustrated are adapted only for circular work; for ovals, special modifications are necessary. Such a series, also consisting of three machines, are illustrated by Figs. 32, 33, and 34. The first is quite similar to Fig. 29, except as regards size, the production

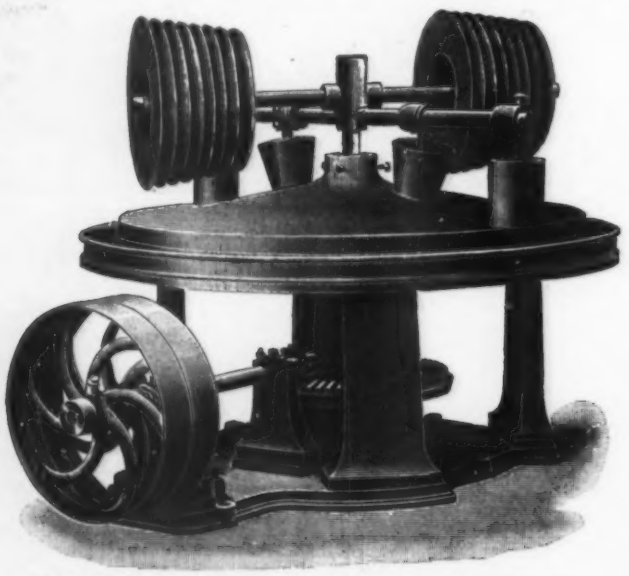
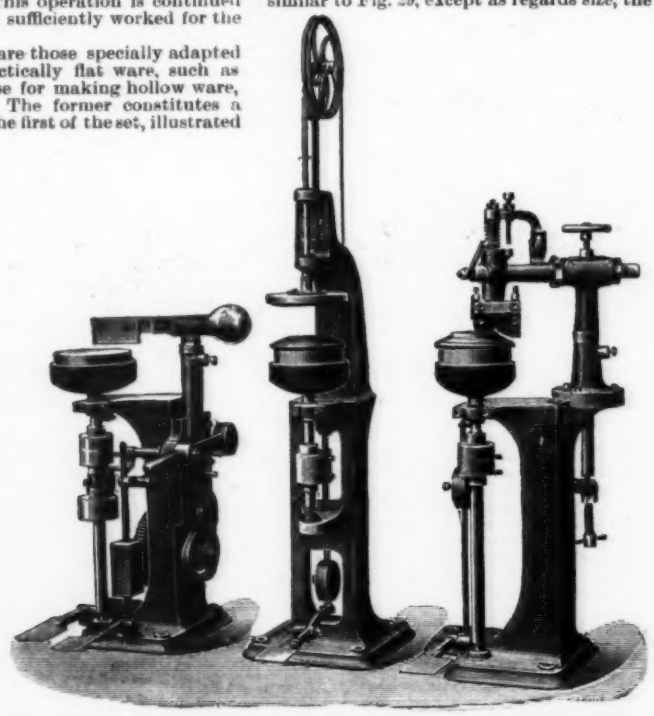


FIG. 28.—"PASTE"-WORKING MACHINE CONSTRUCTED BY MM. FAURE ET CIE., LIMOGES.



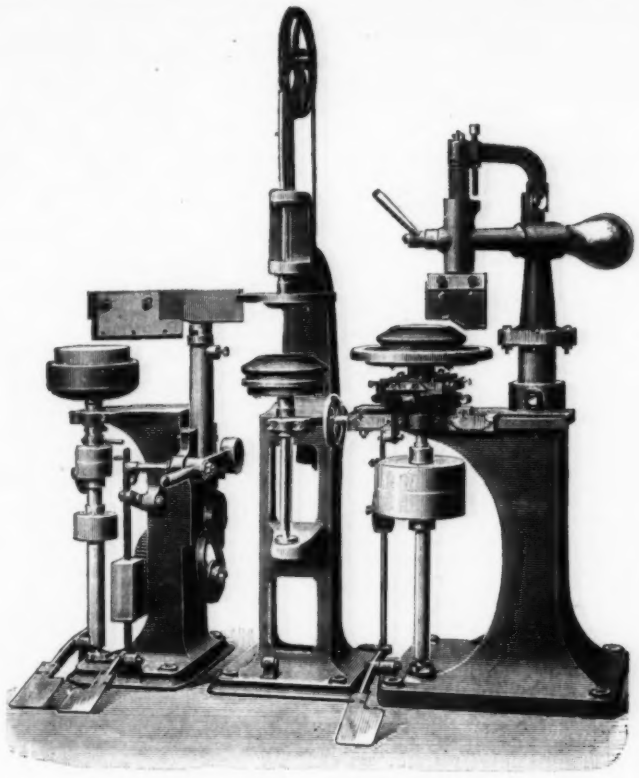
FIGS. 29 TO 31.—MACHINES FOR THE PRODUCTION OF FLAT EARTHENWARE CONSTRUCTED BY MM. FAURE ET CIE., LIMOGES.

CLAY-WORKING MACHINERY AT THE PARIS EXPOSITION.

piece is fixed, and the mold rises and falls. Fig. 27 is another press for tiles, constructed by the American Clay-Working Machinery Company, Bucyrus, O., U. S. A. It is the largest machine of the kind shown in Paris.

We now come to the consideration of another branch of machinery used in the clay-working industry—that in Fig. 29, consists of a turning table on which a lump of paste is placed; upon this ball an iron former or blade fixed to a vertical arm is brought down. The movements of this arm are automatic, and are controlled by cams. The piece of paste upon the revolving table revolves also, and as the blade descends on it, it rapidly spreads out into a thin blank of absolutely of the blank being an identical operation in each case. The press, Fig. 32, is also very similar to that shown in Fig. 31. The third, Fig. 33, is neither more nor less than an elliptical lathe; the dimensions and proportions of work done by these means can be varied within considerable limits; the oval calibrating machine exhibited, Fig. 33, can treat objects measuring 12 inches

across the major axis. For large oval forms the mechanism required is more complicated. A Faure machine for this purpose is shown in Fig. 34, which is a beautifully designed piece of work, and is made in three sizes, one for dishes of 12 inches, a second for those up to 19 inches, and the third 25·6 inches, all measured on the major axis. For calibrating pieces with deep hollows, such as basins, etc., machines of a different kind are required. Such a one is illustrated by Figs. 35 and 36. The general view shows the arrangement of the



FIGS. 32 TO 34.—MACHINES FOR THE PRODUCTION OF OVAL EARTHENWARE.

machine: the vessel in this case is a cup, and the clay is set in the formed receiver placed at the top of a vertical spindle which can be raised or lowered by the pedal; the spindle is driven by a belt on the horizontal pulleys. Figs. 37 and 38 are details of the calibrating device with the contouring blade in two positions. In order to give the necessary double movement, vertical and horizontal, to the former, which is mounted on the horizontal bar shown in Fig. 37, the handle is provided with a cam acting on the holder. By shifting the handle the former is forced into the clay and gradually pressed forward until the form of the vessel is complete.

M. Faure's exhibit includes a number of others for pattern-making, polishing, etc.

The foregoing descriptions include the entire range of clay-working machinery exhibited in Paris. It is much to be regretted that it is not more international, and especially that Britain, in this as in so many other cases, is conspicuous by her absence; it is a branch of industry which she cannot afford to relinquish to foreign competitors. As will be gathered from what we have said, France occupies a front place in the manufacture of this class of machinery, not only of the standard type, but of special kinds; and that the work of French makers is well appreciated abroad, is shown by the constantly increasing export trade in clay-working machinery.

As to the exhibits of ceramic products, they form many most remarkable collections; art pottery, and much of that strictly industrial, do not fall within our province, but did space permit, much could be said of the admirable and miscellaneous collection of constructive materials, sanitary pottery, decorative ceramics, etc., contributed by several nations, notably by France,

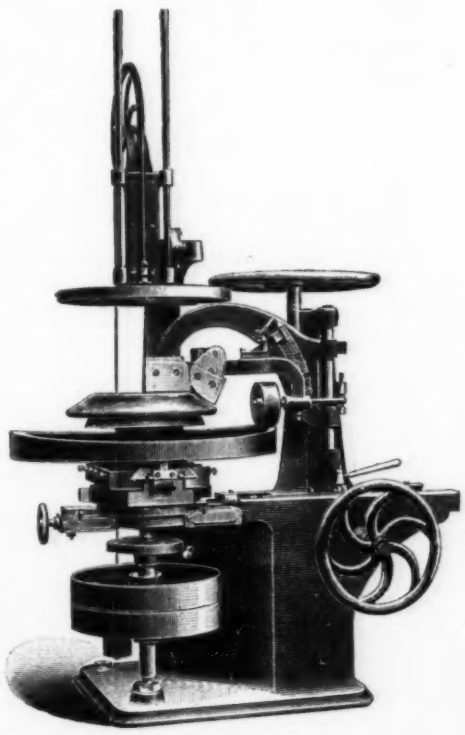


FIG. 35.

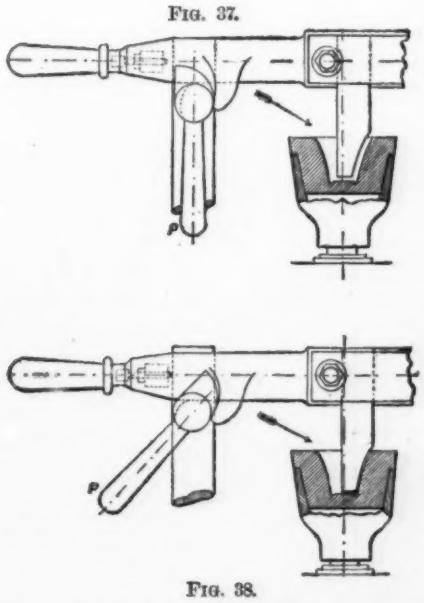


FIG. 37.

FIG. 38.

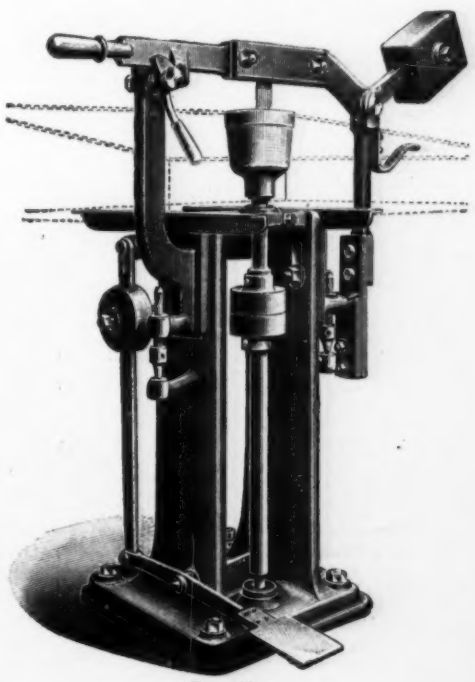


FIG. 36.

FIGS. 35 TO 38.—MACHINES FOR THE PRODUCTION OF HOLLOW EARTHENWARE.

CLAY-WORKING MACHINERY AT THE PARIS EXPOSITION.

As the machines are well designed and absolutely rigid, the work can be carried on very rapidly; the process is a purely mechanical one. Although the machine appears extremely simple, and indeed is so in reality, many difficulties had to be overcome to protect the plastic paste from being deformed or air becoming imprisoned. Besides the machines we have described, and regrettably not by Britain, which is represented by a few small exhibits. Especially noteworthy and original is the decorative stoneware by M. A. Biget, which promises to play an important part in architecture. M. Emile Muller is also a notable exhibitor: the mosaic tiles of Sand; and the exhibits of the brick company of Vaugirard.—Engineering.

MAKING CHISELS AND OTHER TOOLS FROM FILES.

By WALTER J. MAY.

As a matter of convenience, chisels, drills, punches, and tools of a like character are often made from old files, and while some answer well, others fail, and fail chiefly because they were not properly treated, says The Practical Engineer. In selecting the files to work up, squares usually are best, and the fine-cut kinds are to be preferred, as the metal is not bruised so deeply as with first cut and rough files. Of course, in a workshop where files are plentiful no very great care is taken in making up chisels, but where they are wanted good a lot of time is taken, and eventually it is usually cheaper to buy hexagon or octagon tool steel than to work up scrap files, unless the smith has "nothing to do, and plenty of time to do it in."

The first thing to be done is to soften the files, and this is most easily done by placing them in a flue where they will remain at a dull red heat for from five to twelve hours, the object being to anneal them right through. Or make them slowly, but thoroughly, hot right through in the forge, drawing to a bright cherry red, and then allowing to cool slowly; but this leaves the metal rather more brittle than when the first process can be adopted.

Having the files annealed, they should be ground until the cuts are removed, as this gives the best metal to work with; but this grinding is not absolutely necessary, and in the trade workshop is rarely done, save to kill time, as with proper tools at the forge, and skilled men to use them, the metal is worked up decently. Still, where there is time, one may as well do things well. In forging, the files should be made to a full red, being careful to heat with a low blast, and take time to get the center of the steel hot or you will split it up when you commence to use the hammer, high carbon steel being very different to iron, and can be melted on the outside under a strong blast while the center is hardly red hot. Cut off the tang of the file to get it out of the way first, then draw the bar down to an octagon shape with the hammer, and finish with a safe hammer or flatter if you have a striker, but if not the hand hammer must do all the work. The blows of the hammer must be dead ones given with some force, and while not having the metal above a cherry red it must not be hammered black or it will split, and the cracks will probably not show until the tool is tempered and may be ground. Having drawn the metal into the right section, the cutting end if a chisel, or the shaped end if a punch, must be drawn down, after which the tool should be cut off to the right length and the head finished. Drills will have the heads made square, or of the shape best fitted for the chuck or stock in which they are to be used, and those for use in a ratchet brace should fit properly without packing.

When the tools are forged they should be filed or ground up preparatory to hardening and tempering, and then very carefully examined to see if any cracks exist, and if the work has been properly done filing will be quite an easy job comparatively; but, of course, all kinds of filing is hard work when persisted in. In all tools a bright side should be made for the color to run on, as it is thus more surely seen.

In tempering, the tool should be made a full-blood red for a sufficient distance from the end to enable the heat to cause the color to run, and this heating should be slow enough to cause the center of the tool to be practically as hot as the outside—there is always a slight difference, perhaps a dozen degrees—and dip in hot water to blacken the surface. Rub the brightened side at once with a piece of dry sandstone, and watch the bands of color move down until the purple band just reaches the end, and then quench at once in hot water. If you have the yellow shades on the edge of tools made from files, you will find them very liable to split and chip off, but with many of the tool

steels the yellow shades are right. Carpenters and shoeing-smiths' rasps when made into tools should be tempered to the yellow shades, as the steel is usually of a milder quality than that used for ordinary files, and consequently the higher tempering is necessary.

In hardening and tempering high carbon steel, always use hot water to reduce the shock given to the metal, and dip the article steadily and not too rapidly into the water with a circular motion. If you dip high carbon steel to a given point into cold water and hold it there, you will in all probability get water cracks, and with chisels, punches, and the like kind of percussion tools such cracks are often dangerous, as the tool breaks off suddenly and the fingers get more or less smashed or damaged.

Be careful also that you do not overheat or "burn" the steel in forging, or about a couple of blows will smash the tool; and in annealing, if you must plunge the metal into anything, use thoroughly burned ashes free from carbon or sulphur. If you use ashes holding carbon, the steel in cooling will absorb some and become harder; if you have sulphur present, its brittleness will be increased; and if you use lime, the carbon on the surface will, to some extent, burn out, and thus soften the outside of the steel and make it awkward to work with.

As a rule round files do not forge well, but with some makes they work worse than others, and decidedly, for punches, round files are inferior to square ones, as there is always a tendency to avoid forging sufficiently, and this alone is a point which is often fatal to many tools made from scrap steel.

Thin flat files, when annealed and ground, may often be drawn down and made into stiff hacksaws, but the hardening and tempering presents a considerable amount of difficulty. The teeth are cut with a three-cornered file, and the blades ground thinner at the back than the front, and after hardening the temper should be drawn to a purple on a plate heated bright red, the blades being turned over from time to time to keep the blades equally heated. Unless the color is equal from end to end the saws are not up to much, and in this lies the difficulty.

THE PARALLELOGRAM OF MOTIONS.

REPLY BY C. W. MACCORD.

To the Editor of the SCIENTIFIC AMERICAN:

In the SCIENTIFIC AMERICAN SUPPLEMENT of December 15, 1900, I find a discussion of my article on the Parallelogram of Motions (published by you on November 17), by Mr. George N. McDaniels, in reference to which I beg space for a few comments.

Mr. McDaniels, referring to the point P in Fig. 5 (here reproduced), proceeds as follows (the *italics* being mine):

"*The author thinks,* by the laws of the parallelogram, the point in question *ought to move in the direction P L*, whereas it does not. The fatal step in the author's reasoning is that the law of the parallelogram never said the point in question would move in the direction $P L$. In concluding that the point P should move in the direction $P L$, the author *has entirely left out of consideration* two components of the velocity of P, as we shall presently see.

"I. P, regarded as a part of $A P$, has a component of velocity $P m'$ in the direction of $A P$, and a component $P u$ (*a fact that the author omits*), perpendicular to $A P$.

"II. P, regarded as a point of $B P$, has a component of velocity in the direction $B P$, and a component $P v$ (*a fact that the author also omits*), perpendicular to $B P$."

Now, lest some of his readers who may not have seen my original article should imagine that this piece of fiction is founded on fact, I will in my turn quote something from that article, which my critic has judiciously "omitted."

I wrote, and Mr. McDaniels read, that "$P R$ represents, in both direction and velocity, the motion of P at the instant considered. In fact, since $P m'$, $P n'$, are absolute components, it is clear that the resultant motion $P R$ must be the diagonal of the rectangle $m' u$, and also the diagonal of the rectangle $n' v$, which by this construction it is." Which shows that I do not think that P "ought to move in the direction $P L$;" and also that I did not "omit the components $P u$, $P v$"—which indeed is shown by Fig. 5. That is to say, my critic asserts that I think what he knew I did not think, and proves it by one bold misstatement and two acts of *suppressio veri*.

Mr. McDaniels, however, quotes me correctly as saying that (after the absolute components $P m'$, $P n'$ are determined):

"If now, as one might be apt to do, we complete the parallelogram, the resultant motion of P would be the diagonal $P L$." I said, and I repeat, that "one might be apt" to make this mistake, because I have seen it made scores and scores of times by those whose instruction was not so far advanced as to guard them against it by pointing out the difference between the cases shown in Fig. 1 and Fig. 5. And the mistake is the more excusable, because in many practical cases it is not a mistake in effect, but gives the correct result.

My critic flippantly remarks that "In the talk about the fact that P is not a free point, there is certainly a betrayal"—whatever that may mean.

Now, the motion of P in Fig. 5 is unquestionably a constrained motion if there ever was one; and it is equally certain that in Fig. 1 (here reproduced) the

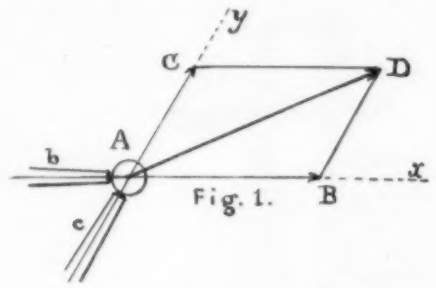


Fig. 1.

center A of the billiard ball, in order to respond to the impulses of the cues b and c, so that $A D$ shall be the true resultant of the components $A B$, $A C$, must be a free point.

C. W. MACCORD.

Stevens Institute, Hoboken, N. J., Dec. 17, 1900.

[Continued from SUPPLEMENT, No. 1308, page 20892.]

NEW AND SIMPLE METHOD OF MAKING TELESCOPIC OBJECTIVES.

By EDMUND M. TYDEMAN.

WHEN the surface of the glass has been brought to a fine and satisfactory semi-polished surface by grinding, as previously detailed, the polisher may be prepared; this is a part of the process that demands the most minute and careful attention if it is our object to produce a surface that shall not deteriorate in figure even to the extreme edge. An iron tool similar in every way to the grinding tool must be prepared, but it may be left without the surface squaring and grooving, also it need not be bored out at the back.

Prepare a cement by melting together clean paraffin wax and rosin that has previously been melted and strained through fine muslin (the rosin must be the "water white" used by varnish makers), about ⅝ paraffin wax and ⅜ rosin is right. It must be melted slowly and thoroughly mingled. The iron tool is then to be heated to a blood heat, laid face upward on the bench and leveled, and a strip of stout paper tied around its edge, leaving ¼ inch projecting beyond the surface. Upon this the hot cement is to be poured; but before pouring it on the hot iron, see that there are no air bubbles in it. Pour it on the center, letting it gradually spread to the edge, filling up the whole space about ¼ inch deep. When it is thoroughly cold, the paper may be stripped from the edge, and the tool put in the lathe so that its cement face may be turned to match the concave brass gage, the edge being finished with a neat ⅛-inch chamfer of 45°.

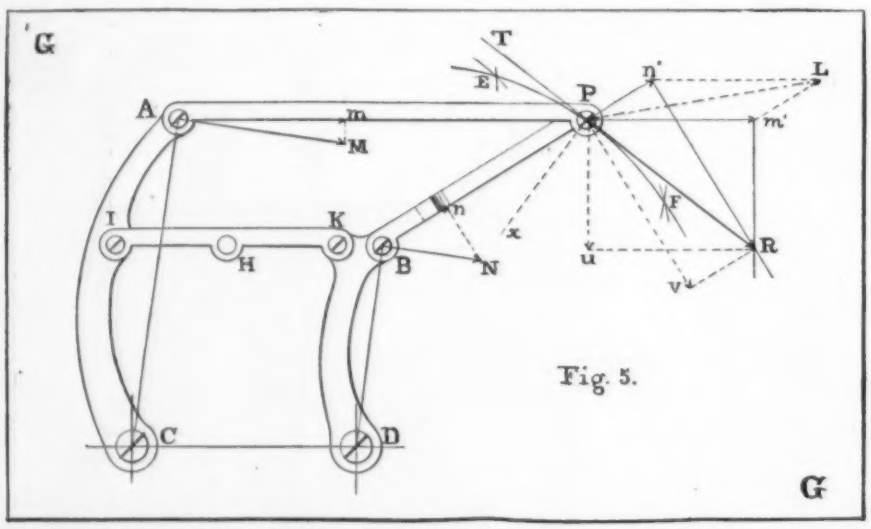


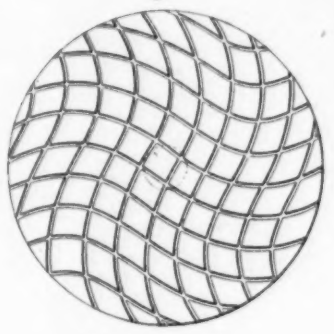
Fig. 5.

ILLUSTRATION OF A MODEL FOR DEMONSTRATING AN EXCEPTION TO THE PARALLELOGRAM OF MOTIONS.

Now prepare a strip of thin sheet brass about 9 inches long by 2 inches wide and trim it into the shape of an S (see Fig. 4) about 1½ inch wide. Lay this across the cement face for a template, and by drawing a small round-nose lathe tool along the edges, plow out the grooves, dividing the face of the cement polisher into a number of lozenge-shaped squares, as in Fig. 4, with the "volute," or rather "serpentine," grooving between them (Fig. 3). The grooves will be about ⅛ inch wide and ¹⁄₁₆ inch deep, using the same precaution, as in straight grooving the grinding tool, to make the system of squares and grooves eccentrical to the surface. The face of the polisher must now be very carefully and evenly warmed, by holding it face downward some 10 or 12 inches above a large stove or range, and when the surface just begins to soften it is quickly and firmly forced down upon the middle of the cold glass, which is then to be placed in position on the table of the machine (Fig. 1), and left for at least half an hour. The glass must previously have been wiped thoroughly clean and dry. At the end of this time, with a camel's hair brush or feather, run a little rouge water round the edge of the polisher, and then gently knock the edge of its iron back with a mallet, which will at once free it so that it can be lifted off the glass, which is now again to be wiped very clean, carefully removing any stains or marks left by the polisher. It is then to be brushed with a thin paste of rouge and water and the polisher placed upon it.

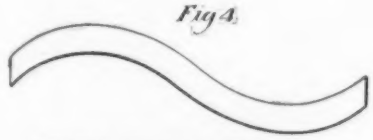
For impelling the polisher quite a different plan must be adopted from that used for the grinding tool,

Fig 3.



CEMENT POLISHER.

Fig 4.



TEMPLATE FOR POLISHER.

because toward the end of the polishing process we find that very considerable force is required to move the polisher over the surface of the glass.

The trouble experienced in securing a good regular figure by machine polishing arises from two principal causes: one, the faulty composition or make of the polisher, giving rise to sticking and clinging at one or more particular spots, a fault to which a pitch polisher is peculiarly liable, and to avoid which a system of paper polishing was invented: but this process is slow and moreover exceedingly difficult for an amateur to accomplish satisfactorily on a large surface, although I believe the French use it successfully for very large apertures. The second is, that the impulse being of necessity given to the polisher above the line of contact of the surfaces, the polisher toward the end of the stroke, when considerable force is required to move it, shows a tendency to lift or tilt, and consequently to press down more heavily upon its forward edge, and thus more or less injure the regularity of the figure; and for this reason hand-ground glasses often prove superior to machine-ground ones, for in hand working, a dextrous and experienced workman almost unconsciously compensates for it.

To the end of the driving rod, B, is attached the light steel four-armed frame shown in Figs. 5 and 6; the

Fig. 5.

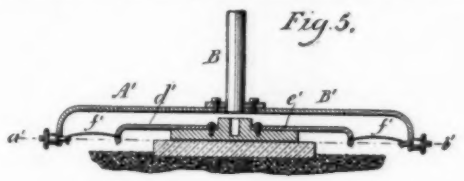
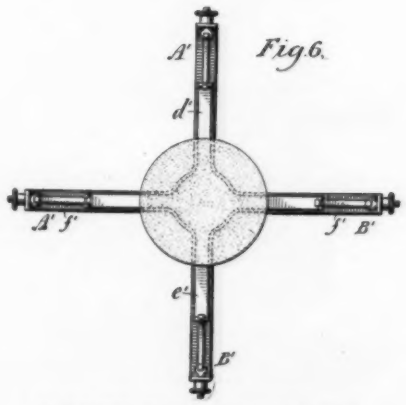


Fig. 6.



CARRIER FOR THE POLISHER.

cross arms, $A' B'$, being about 20 inches long. The back of the polisher has also screwed to it a light metal frame, $d' e'$, carrying four corresponding but shorter arms some 15 inches wide. Four 2½-inch links, $f f$, connect the arms on the polisher to those carried by the driving rod, B. These arms are adjusted in such a way that the points of attachment for the links are in an exact line, $a' b'$, with the contact surfaces of the polisher and the glass, so that whatever may be the force required to move the polisher over the surface of

the glass, or however that force may vary, there can be no tendency to lift it up from or force it down upon the glass at any point in its course.

This arrangement can of course be used for the grinding tool as well as the polisher, but where the tool has to be attached and detached so often, it is inconvenient; and as there is no advantage whatever to be derived from its employment for that purpose, it will be found more advantageous to adopt the very simple plan shown.

With this machine, although we cannot automatically produce a spherical, or parabolic, or hyperbolic surface absolutely at will, we are always enabled to secure a regular curve, which is the great desideratum; and by closely watching it, and with a knowledge of how the various motions tend to modify the figure, we can with a very little trouble secure, even on a surface of very considerable size, almost any figure we please—a fact that all object glass and speculum workers well know how to appreciate, understanding, as they well do, the extreme difficulty of obtaining on an extended surface a figure of any kind that will be found uniform at the center and edge and without any zonal inequalities.

If the grinding has been carefully done, the glass will be found to have a perfectly spherical surface, and this may be very easily verified, even at this stage of the work, by testing it at the center of curvature by means of M. Foucault's and Dr. Draper's elegant processes. To maintain this figure during the polishing, or so to modify it that it may become a perfectly elliptical or parabolic surface, is the goal for which we are striving.

Speaking generally, it will be found that the best results will be obtained from the above machine, in polishing, by working the polisher in a cycle of 24 strokes; namely, 3 side strokes, 2 middle strokes, 3 side, 2 middle, 3 side, 2 middle, 3 side, 2 middle, then 4 circular or elliptical strokes; the machine being adjusted to revolve the glass once in about 50 or 52 strokes, and the polisher once in about 30 strokes and in the same direction with the glass, using a 4-inch stroke for the middle and falling off to about a 3-inch stroke as it approaches the side of the glass; the side movement being confined to about 1½ inches. This will be found to polish a 10-inch glass in about five hours, but the time taken in polishing will very largely depend upon the quality of the rouge and the fineness in finish of the ground surface. At the end of this time it should be found to have a good elliptical figure, without any sign of zonal inequality; and the curve should not fall off, even at the extreme edge. If this is found to be the case upon testing it as hereafter described, to bring it to a parabolic figure use 2 side, 3 middle, 2 side, 3 middle, 2 side, 3 middle, 2 side, 3 middle, and then 3 circular strokes, a cycle of 23 strokes. This will generally be found to accomplish the purpose after 5 or 10 minutes' working.

Should the figure be found to have been slightly overdone, so as to run it into the hyperbolic, reversing the motion of the top ratchet, and setting it at about 60 to 80 strokes for one revolution of the polisher, will sometimes bring it back again toward the parabola.

To obtain a perfectly spherical surface in the first instance, adopt a shorter cycle of strokes, and increase the circular or elliptical strokes to 4, the polisher moving the same as first described; this will sometimes produce an almost perfectly spherical surface, but it is a figure which is extremely difficult to hit.

When the motion of the top ratchet is reversed, and the surface polished entirely in this way, an exaggerated oblate spheroid is almost certain to result, other things being equal, that is, a concave surface having the focus of its center much longer than that of the edge. When such a figure as this turns up, it will often be found to have apparently a great lump in the center. The best way to correct it is to shave down the squares of the cement polisher gradually from the center to the edge all round, but more decidedly as the edge is approached, leaving them only about $\frac{1}{16}$ inch wide at their extremities, and then working the polisher over each chord, using only short straight strokes. This will generally correct it, or a 6-inch, or even a 5-inch polisher may be used, with strokes just long enough to bring the edge of the polisher well up to the edge of the glass on the middle strokes. In this case straight strokes varied with a few circular ones should be used, and the squares should be more or less graded down toward the edge. After the mirror is finished and tested it requires silvering, which may be done in either of several different ways.

In grinding and polishing convex surfaces, the same simple principles are acted upon as for concave surfaces.

For polishing use George Zucker's purple "pebble" rouge, or if an hour or two of time is no object, then use the ordinary glass-grinder's lump rouge.

Toward the end of the polishing a very little rouge and water applied with a feather to the edge of the glass will be sufficient, occasionally spraying it with a fine spray of water to prevent it from getting dry.

Polished surfaces in glass or metal can be conveniently tested in a still underground apartment or cellar by the admirable and delicate process published by M. Foucault, of Paris, and by the late Dr. Draper, of New York. The details are much too long for insertion here, but may be obtained from the records of the Smithsonian Institution for 1864. Before testing it finally, the glass must be allowed to cool down if it be a very large one, for an hour at least, or a false judgment will be very likely to be formed concerning it.

The very best way of testing it, however, is to place it *in situ* in its own proper mounting, and turning it to a large fixed star, such as Vega, using a good eyepiece, giving a power of about 40 to the inch of aperture. After having focused it very accurately make a mark upon the draw tube of the adapter, and then measuring say ½ inch on each side of this focus mark, make two other marks on the draw tube, at precisely the same distance from it. Upon pushing the eyepiece in, or upon pulling it out to either the inner or outer mark, the enlarged star disk ought to show identically the same appearance, and to measure precisely the same size. If it do this, without any doubt about it, then the glass is a good one and well corrected. Should the star disk appear bigger when the eyepiece is pushed in to the inner mark than it does when it is pulled out to the outer mark, and also have an ill-defined and misty appearance at the edge, and just the reverse when it is pulled out, then the figure is over-corrected, and has passed into the hyperbolic. Should the reverse conditions appear, then it is under-corrected, and either spherical or of an oblate spheroidal figure. Should there be other irregularities of the surface, they will manifest themselves as spots or rings of greater light or shade on the enlarged star disk, the places where the light is more condensed being (as a rule) the parts of the surface that need polishing down.

Fig. 7*A* gives a view of a big star as it appears when properly focused in the field of view of a 10-inch telescope upon a fine night, a small clear disk surrounded with two or three delicate diffraction rings, the first ring being much more distinct and conspicuous than the others, which are finer and fainter. The finer the

Fig. 7.

TELESCOPIC APPEARANCE OF A STAR.

nights, the less numerous and conspicuous are these rings; and the larger and better the telescope, the smaller and sharper and steadier will be the star disk. Figs. 7 *B* and *b* are representations of the appearance of the enlarged or spurious disk of a first magnitude star as seen through an over-corrected glass, when the eyepiece is pushed within and drawn out beyond the true focus respectively. In one case the light shows a tendency to condense around the edge, and in the other to condense toward the center, while the disk is unduly enlarged, and the edge of it more or less confused. A pretty high-power eyepiece should be used in making these tests.

The test for achromatism, which of course is not applicable to reflectors, for they are not troubled with any chromatic aberration, is that on looking, for instance, at the bright edge of the moon, upon pushing the eyepiece in, there will appear a border of purple, in some makers' instruments inclining toward wine or claret color, and upon pulling the eyepiece out beyond the true focus, there will appear a border of light green. Should a reddish tinge appear when pushed within, and a violet colored border when pulled out, the glass is under-corrected for color; and should the reverse be the case, it is over-corrected for chromatic error; and in this case the performance of the object glass can often be noticeably improved by separating its component lenses a little, by pasting three tiny strips of paper on the extreme border of one of its lenses, making a small equal space between them.

When it is desired to apply an extremely rigid test to ascertain the perfect achromatism of any object glass, by which even the small amount of uncorrected secondary color, due to the "irrationality" of the spectra, is made conspicuously manifest, we may employ the very ingenious plan devised by the late Dr. Blair, professor of astronomy in Edinburgh, for the purpose of testing his fluid object glasses (erroneously attributed to Sir George Stokes, I see, in Messrs. Cooke & Sons' valuable little handbook, "Telescope Objectives"), namely, of covering up one-half of the O. G. by a semicircular shutter, and focusing it with a high-power eyepiece upon a distant white vertical line on a black ground, or vice versa, such as the rod of a distant weathercock; the outstanding uncorrected colored fringes thus being freed from the compensating offsets of their complementary colors, will be made greatly more vivid and intense and consequently more visible.

The "form" of the object glass, that is, the relationship of the curves of its lenses to each other, while it is of great importance, has been too much neglected by many makers; indeed, some object glasses are so faulty in this respect as to greatly limit their usefulness. An object glass may have its various aberrations perfectly corrected, and yet be so badly designed as to allow of a very limited field of view, and be altogether too sensitive to any accidental small disturbance in the adjustment of its lenses; or the kinds of metal used may allow of a very large and disagreeable amount of outstanding secondary spectrum.

A good "form" of object glass, and one that will be found to have very little outstanding secondary color, can be made of the very fine metal supplied by M. Mantois, of Paris, successor to M. Pfeil & Sons, Rue Le Brun; using "No. 3426 Crown léger" and "No. 3473 Flint léger," and for a 5-inch object glass adopting the following curves, given below in inches radii:

For the outside surface of the crown lens, $+20\frac{3}{4}$ inches. Inside surface of same lens, $+17\frac{1}{2}$ inches radius. Inside surface of the flint lens, $-17\frac{1}{4}$ inches. Outside surface of the same (that is, the side next the eyepiece), —69 inches. The flint lens is, therefore, double concave, and the object glass will be about 6 feet 6 inches focus. Or a good object glass, of somewhat shorter focus, may be made of M. Mantois' glass; "Crown No. 3352" and "Flint No. 3541" (all these glasses will be found in their most recent list for this year), using the radii: Crown, outside surface 18 inches, inside surface +27 inches. Flint, $-25\frac{1}{2}$ inches, and $-68\frac{3}{4}$ for the concave surface next the eyepiece.

Anyone who wishes to go into this subject thoroughly, namely, the theory and practice of getting out the curves for the lenses of achromatic telescope object glasses, cannot do better than consult the very able and explicit papers on the subject by the late Prof. Littrow, to be found in the Transactions of the Royal Astronomical Society, London, volume 4, page 599, which can be obtained at nearly all our public libraries. He will find the subject—which really requires a treatise by itself—handled exhaustively and in a very simple fashion, both mathematically and trigonometrically, so that almost anyone may understand it.

It remains to add a few directions for the grinding and polishing of flat surfaces. To produce a rigidly flat surface in glass is considered one of the most difficult feats in practical optics. The process is, however, essentially the same as for curved surfaces. The principal difficulties are, first, in getting up the grinding tool or surface plate to the greatest perfection possible and keeping it so. Four flat tools will have to be prepared, three of them being of equal size and considerably larger than the glass to be ground. These must be planed and then finished up by careful scraping and grinding, after the manner of surface plates, until they so perfectly match together that they are shown to touch all over upon gently rubbing them one upon the other: no one of the three being concave or convex to the others. This is a delicate and tedious job. The second particular is to see that the glass is smoothed up on the fourth tool, which is preferably a bell metal tool of about the same size as the glass, that after having been carefully matched to the surface plates is, while being used as a grinding tool, to be every now and then tested, and if necessary corrected by them. The glass must be wrought to the very utmost possible fineness, in fact to a semi-polish, upon this plate, using the finest washed emery powders, and finally a little of the finest washed oil-stone powder; so that the minimum of rouge-polishing will be needed to bring it to a lustrous surface. A flat cement polisher is then made, only a trifle smaller than the glass, and the glass worked upon it in the lathe with a number of intermittent sweeps across the face, keeping it on only a few seconds at a time to avoid heating, and sticking and breathing upon it toward the last, almost continuously, until it is brought up to a fine and satisfactory polish.

It is then tested by first carefully wiping it, and comparing it with a fiducial polished glass plane, upon which it is carefully dropped and allowed to settle into contact with it, until, upon letting fall upon it obliquely the light from a white cloud, and moving it up toward the level of the eye, the system of colored bands, due to the diffraction of light by the thin film of air between the plates, called "Newton's rings," appears. If the glass surface be flat, there will be seen a number of brilliantly colored bands or stripes stretching straight across the plate. If convex or concave, these bands will be curved or even circular. Upon raising the two plates up toward the level of the eye, these circular bands will be seen to contract or expand, and while being thus raised these colored bands will always move toward the thickest film of air. The parts toward which these bands appear to move while being raised are therefore the hollow or concave places in the plate; or if they move off toward the edges of the plate, the surface is convex. To correct the surface when found to be convex, use a smaller polisher, and vice versa. The polisher is to be divided into squares, of the size of half an inch, by one-sixteenth inch wide grooves; the grooves may be straight.

Should any of the polishers used in glass grinding bind or stick at one particular spot, or should one work erratically or unevenly or in jerks, it must be immediately removed, its surface scraped or brushed clean with a piece of steel scratch card, to be obtained at any woolen mill supply store, and the grooving must be cleared out and properly regulated if it needs it. They must not be allowed to fill up. The face of the polisher must again be gently and evenly warmed, and quickly applied to the clean dry surface of the glass, and left until cold. If the polisher be a large one, each square may also be cross-scratched with a steel point × thus. Sometimes the polish will come on very strongly at the middle, while the edge is entirely untouched, and this after the most persistent efforts to overcome it. This trouble may often be remedied by increasing the rate of the top ratchet wheel. But should it continue to any marked extent in spite of every effort, a circular disk as big as a half dollar may be cut from the center of the polisher. The grooves should always be kept as clear as possible while polishing.

Arising probably from some want of homogeneity in the cement facing, a new polisher will sometimes have to be made before this vexatious state of things can be satisfactorily corrected, and the polish proceed with regularity and smoothness; but to continue polishing under such circumstances would almost inevitably ruin a surface. A polisher of beeswax hardened with the least trifle of rosin may be substituted for the cement with good effect in polishing small glasses, or even one composed of glue and treacle.

In making prisms, the edges must be protected by cementing to the sides of the prism four pieces of parallel plate glass, before either grinding or polishing either of its surfaces. Canada balsam is the best material to use; making the whole block of glasses hot enough to evaporate most of the balsam, pressing them closely together and then allowing it to get cool. It is easily dissolved asunder by heating and then cleaning with hot alcohol.

Small lenses are cemented to a small true chuck in the lathe with hot shellac, and well pressed home, turned with a diamond, or with the broken point of an old square file, using plenty of turpentine for a lubricant, until they perfectly fit the gage; and after being fined up with emery, etc., are polished, by tying a piece of white "duck" or "jean" over the face of the matrix, which is then revolved rapidly in the lathe, and the lens (cemented to a small convenient handle, and well anointed with plenty of rouge and water) worked backward and forward upon it. Considerable force may be used, and five minutes will suffice to bring a half inch diameter convex lens up to a good polish. For very small lenses, ¼ inch or less diameter, a polisher made of common solder or block tin, and accurately turned out to curve with a steel gage, will put a good polish on in one or two minutes. It is in this way that the small lenses for the best microscope object glass lenses are polished.

To complete the optical part of our work, it remains only to say a few words in regard to the most approved form of eyepieces.

For reflecting telescopes of the Newtonian construction, those called "positive" eyepieces will be found preferable; consisting of two plano-convex lenses of nearly equal foci and size, placed with their curved sides toward each other, and separated by about $\frac{4}{10}$ the sum of their foci. For example: Focus of eye lens 1 inch, of field lens 0·9, diameter of eye lens 0·5, of field lens 0·6, distance between their interior surfaces 0·8, with a diaphragm of 0·5 inch aperture placed 0·1 inch in front of the plane side of field lens, the eyehole ¼ inch diameter and 0·1 from lens. Other eyepieces to be made in proportion.

A good Huyghenian eyepiece will be found to perform best with achromatic object glasses. The proper proportions are: Eye lens 0·5 inch, field lens 1 inch, with a diaphragm between them in the focus of the

eye lens, ¼ inch aperture, the eyehole being 0·1 inch diameter and quite close to the lens. The lenses used are plano-convex with their plane sides toward the eye; the diameters of the lenses being ½ inch and $\frac{5}{16}$ inch respectively. The lenses should be placed in separate tubes sliding one within the other, so that the most perfect adjustment for achromatism may be made by actual trial in the telescope, the normal distance of the lenses being slightly more than half the sum of their foci.

A good terrestrial eyepiece having a large flat field, and capable of great expansion, can be made by adopting the following proportions: Eye lens 1¼ inch focus and ⅜ inch diameter, plano-convex, with diaphragm in its focus ⅝ inch aperture; field lens plano-convex, 2⅛ inch focus, 1⅛ inch diameter; distant from eye lens 2⅛ inches. Amplifying lens double convex, 3 inches focus and ¾ inch diameter; object lens convexo-plane 2 inches focus, 1 inch diameter, having a diaphragm $\frac{1}{16}$ inch aperture in its focal point, distance between the two lenses 3⅛ inches. The distance between the two sets of lenses, in this eyepiece, can be varied from 4⅛ to 11 inches or more, more than doubling the power. Eyehole ¼ inch diameter and about ¼ outside the eye lens.

An eyepiece having an extraordinary large field of view may be made with three plano-convex lenses, in the following proportions: The eye lens, ¾ inch focus and ⅝ inch diameter; field lens, 2 inch focus and ⅞ inch diameter. The lenses to be placed 0·1 inch apart, with their curved sides facing each other. The object lens, 3 inches focus and 1⅛ inches diameter, and 1·7 inches distant from the field lens, with their flat sides facing each other, and a diaphragm ⅝ inch aperture between them, in the focus of the first two lenses. By pushing the two largest lenses much nearer together, this eyepiece answers admirably for the microscope.

The size of the minor axis of the diagonal plane mirror for a Newtonian reflecting telescope is

$$x = \frac{D\,A}{F} + a$$

where F = the focal length of the speculum, A its aperture, a = the aperture of the field lens of the lowest power eyepiece, D the distance of the plane mirror from it, and x = the minor axis, i. e., the width of the plane mirror.

In making the lenses for an object glass, the very closest attention must be paid to keeping the surfaces perfectly true and parallel with each other, or the aperture of the lens will be greatly reduced in centering. The best plan to adopt is, after one surface of a lens has been finished and the other surface roughed out, to cement the finished surface down to a true ring chuck in the lathe and very carefully turn, with the point of a diamond, a true circle on the unfinished surface near the edge, the nearer the better, for a guide to grind down to.

When the lenses are finished, they are centered by cementing them to a chuck in the lathe, having a hole through its center; then viewing a distant point of light through the middle of the lens, the lathe meanwhile being slowly revolved, and the cement not having been allowed to get so cold that the lens cannot be shifted by pressure, the glass is gradually pressed into such a position that the point of light appears to remain perfectly still while the lathe is revolving. When this is the case, the cement is allowed to set hard, and the edge of the lens is turned perfectly true with a diamond, but proper precautions should be taken that in case the lens should be jerked off in so doing, it will not be broken or damaged.

FRENCH LOCOMOTIVES AT THE EXPOSITION OF 1900.*

COMPAGNIE DU NORD.—The compound locomotive exhibited at Vincennes by the Compagnie du Nord is

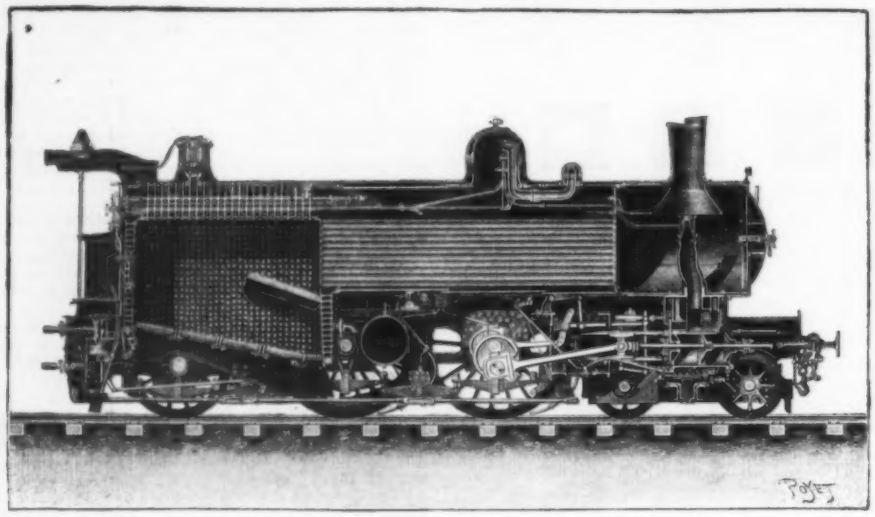


FIG. 1.—LOCOMOTIVE OF THE COMPAGNIE DU NORD.

the last expression of the modifications and improvements introduced into the first type of compound engine put in service in 1886. This very remarkable model forms the culmination of a series of progresses made by degrees in the continuous research upon speed for the most heavily-loaded trains. Before compound engines were put in service the hauling of trains of very high speed was effected upon the system of the Nord, up to 1888, by two-cylinder and simple-expansion locomotives of the type called "Outrance;" but at this epoch the fact had to be recognized that the power was becoming inadequate in these engines for very fast trains, the heavy load of which, hauled at a very high speed, was classified in a category apart. A glance at the increase in speed obtained since 1889 will show the progress that has been made: In 1889, the trip from Lille to Paris was made in 3 h. 45 m., while at present 3 h. suffices to travel this distance of 251 km. In 1889, it took 4 h. 13 m. to go from Paris to Calais (298 km.) At present it requires but 3 h. 15 m. At the same time the 2 h. 15 m. that it took to go from Paris to Saint Quentin (154 km.) has been reduced to 1 h. 40 m.

An examination of the increase in loads will prove of equal interest, since it makes evident the valuable qualities of the compound locomotive. Since the advent of these locomotives, the loads of the various fast trains have not ceased to increase. The progress made in this respect may be seen by comparing the present loads with those that could be hauled at the epoch at which the express service was performed by the "Outrance" engines. At this period, a train composed of 26 axles, say a load of about 120 tons, was considered as heavy, and, with such a load, long gradients of 5 mm. to the meter were climbed at a speed of 66 km. an hour at a maximum. Even with the "Outrances," reinforced by an elevation of the boiler pressure to from 10 to 11 kg., and by the replacing of the cylinders, the diameter of which had passed from 0·432 to 0·46 m., the making up of trains of more than 32 axles had to be dispensed with under the penalty of running the risk of retardations. At present, in daily practice, this maximum of former weight is often greatly exceeded, despite the increase in speed, and, in current service, with a load of from 180 to 225 tons, gradients of 5 mm. are climbed at a speed of 85 km. an hour, which, at a pinch, may be raised to 90 and even 92 with 200-ton trains. Such speeds have at all times been exceeded upon the descent of the incline of 5 mm. per meter that connects Survilliers with Saint-Denis; and speeds of 110 and even of 120 km. an hour have been made there when the load hauled was proportionate to the power of the engine.

This remark shows that it is possible to run at such a speed without any fear. So all the efforts of M. du Bousquet, engineer-in-chief of rolling stock and traction, have tended toward progressively reducing such differences in speed in ascending and descending gradients, by constantly increasing the power of the engines in such a way as to permit them to climb gradients with 200-ton trains at greater and greater speeds.

In constructing the locomotives of type 2642, exhibited at Vincennes, the object of the Compagnie du Nord has been to create engines of sufficient power to descend the gradient of 5 mm. between Saint-Denis and Survilliers with a load of 200 tons.

The increase in power, with respect to the present types of high-speed compound locomotives, required at the outset a much wider grate surface; and, as the length of the engine was thus increased, an increase in its weight inevitably had to follow. A bearing axle was, therefore, added in the rear (Fig. 1).

BOILERS AND ACCESSORIES.—The boiler, with a square fire-box, is registered at 16 kg. It is established in view of an abundant production of steam. Its total capacity is nearly 8 m.³, 5,240 liters of which are occupied by water. The grate surface is 2·74 m.² and the heating surface 208·52 m.².

The cylindrical body is of what is called the "telescopic" form, with three parts, of which the diameters decrease from the smoke-box to the fire-box.

The various elements of the boiler, with the exception of the furnace, which is of copper, are of steel plate. The tubes are of the Serve type and of soft steel, and are of 70 mm. external diameter.

The furnace is provided with a brick arch. The grate has a slight inclination toward the front. It consists of four series of multiple bars, arranged end to end in a longitudinal direction, and resting in a transverse direction upon iron bearing-bars. The ash-box is entirely closed, in order to protect the oil-boxes of the hind axles against the entrance of cinders during the running of the engine. It is closed at its extremity with doors that turn downward. Two large Friedmann injectors, of variable discharge, assure the feed. One of these operates continuously, while the other is designed to serve as a substitute in case of accident.

Steam is admitted to the dome through two superposed slide-valves—an arrangement that facilitates the maneuvering of the regulator.

One of the safety-valves is of the ordinary type and the other of the Adams system, of large discharge and rapid closing. The water gage with cut-off cocks, the gage cocks, and the pressure gage are of the Bourdon type.

THE CYLINDERS AND MECHANISM.—The two high-pressure cylinders are arranged on the outside of the sole bars, and the low-pressure ones on the inside, under the smoke-box.

The volumes produced in the cylinders by the pistons are in the ratio 2·71.

The bodies of the pistons are hollowed and of cast steel. The heads are of cemented and tempered iron, with cast iron slides faced with white metal.

The distributing mechanism is of the Walschaert system.

THE REVERSING APPARATUS.—The distributing mechanism may be connected or rendered independent at the will of the engineman. The independence of the operation of the small and large cylinders is ob-

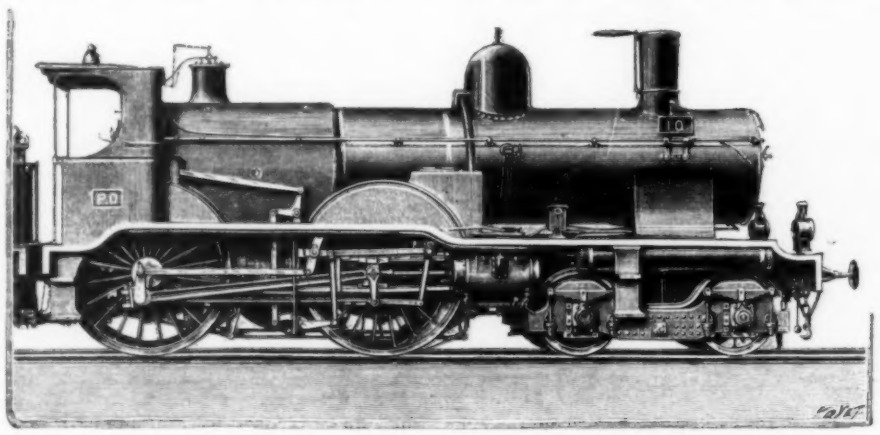


FIG. 2.—LOCOMOTIVE OF THE COMPAGNIE D'ORLEANS.

* Continued from SUPPLEMENT, No. 1236, p. 20231.

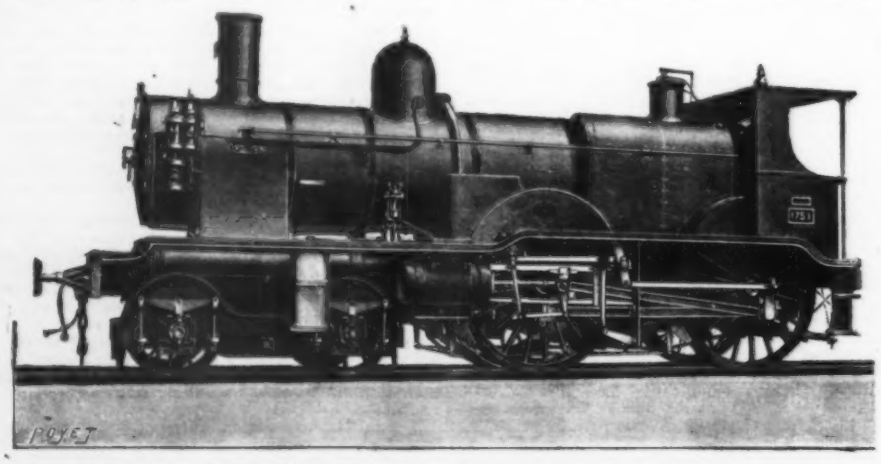


FIG. 3.—LOCOMOTIVE OF THE COMPAGNIE DU MIDI.

tained through a new arrangement devised by M. De Glehn, and that permits of effecting four different operations of the engine: (1) habitual operation as a compound; (2) operation as independent expansion apparatus for starting; (3) operation with the small cylinder alone, in case of accident to the low-pressure cylinders or mechanism; (4) operation of the large cylinders alone, in case of accident to the high-pressure cylinders or mechanism. The to-and-fro motion of the piston is transmitted to the levers that control the revolution of the cut-offs through a very simple mechanism.

FRAME AND WHEELS.—The sole bars are of steel plate. The slides of the oil-boxes are of cast steel. The jointed front truck has a lateral displacement of 40 mm. on each side. The wheels, which are of forged iron, with spokes, are 2·04 m. in diameter. The axles are of Martin steel.

The sand-box is of the Gresham system. The engineman's platform is entirely free, by reason of the position of the high-pressure train of driving wheels in front of the furnace.

The tender, which is carried by two trucks, has a capacity of 20 m.³

COMPAGNIE D'ORLEANS.—The compound locomotive exhibited at Vincennes by the Compagnie d'Orleans, and represented in Fig. 2, is provided with four coupled wheels. It is of the type of the high-speed locomotives of the Chemin de Fer du Midi. The locomotives of this type put in service have entirely transformed the rate of running of the express trains from Paris and Bordeaux, and Paris to Nantes. For the trip from Paris to Bordeaux, it now takes 7 h. 5 m. instead of 8 h. 14 m., and from Paris to Nantes 5 h. 23 m. instead of 7 h. 23 m.—say for the first case a mean commercial speed of 82 km. an hour, and for the second 79 km.

The following is a brief résumé of the measurements of the mechanism and boiler:

Diameter of the high pressure cylinders	0·35 m.
Diameter of the low pressure cylinders	0·55 "
Stroke of the pistons	0·64 "
Horse power	1048
Register of boiler	15 kg.
Mean diameter of the cylindrical body	1·38 m.
Length of the cylindrical body	3·785 "
Thickness of the steel plate of the furnace	0·017 "
Thickness of the steel plate of the cylindrical body	0·017 "
Volume of the water in the boiler with 10 cm. of water above the crown of the furnace	4·3 m.³
Volume of steam	2·412 m.³
Total volume of the boiler	6·712 m.³

The flanged tubes of the Serve system are 111 in number, with an external diameter of 0·07 m. and a length of 3·9. The total heating surface of 192·95 m.² corresponds to a grate surface of 2·46 m.².

The diameter of the coupled wheels to the head is 2·13 m. and that of the wheels of the truck 1·04. The distribution of the load upon the rails is done as follows: Truck, 21,500 kg.; motive axle B. P., 16,750; motive axle H. P., 16,750. Total weight of the engine in service is 55 tons.

The volume of water of the tender is 17 m.³, and its weight in service is 38,400 kg.

COMPAGNIE DU MIDI.—The Vincennes exhibition includes three locomotives sent by the Compagnie du Midi, one of which, of four cylinders and two coupled axles, is a remarkable type of engine for the service of heavily-loaded express trains (Fig. 3).

From 1896 to 1898, the Compagnie du Midi has built twenty-four engines of this model designed for hauling fast trains upon the line from Bordeaux to Cotte, and from Bordeaux to Bayonne. The power of these locomotives permits of their hauling loads of 175 tons, exclusive of the weight of the engine and tender, at a mean speed of 100 km. an hour upon lines of which the profile presents gradients of 5 mm. to the meter. Such speed is reduced to 80 km. an hour with loads of 300 tons, the weight of the engine and tender excluded.

These engines are of the compound 4-cylinder type, the high-pressure cylinders being outside of the sole bars, and the low-pressure ones within, and placed beneath the smoke-box. The high-pressure cylinders actuate the second coupled axle placed beneath the furnace.

The boiler is registered at 14 kg. It is provided with flanged tubes and its internal heating surface is 173 m.². The grate has a heating surface of 2·46 m.². The furnace is of copper and is arched with brick. The fire-box, which is of the Belpaire type, is of steel.

The cylindrical body, which also is of steel, is of telescopic form, the smallest section being in the rear. The feed is assured by two Friedmann injectors automatically primed. Their discharge is 150 liters per minute.

The water gage is of the Chaiou system. The double slide-valve regulator is situated in the interior of the dome. The escapement is variable and of the two-valve type. The smokestack is placed as near the back of the smoke-box as possible.

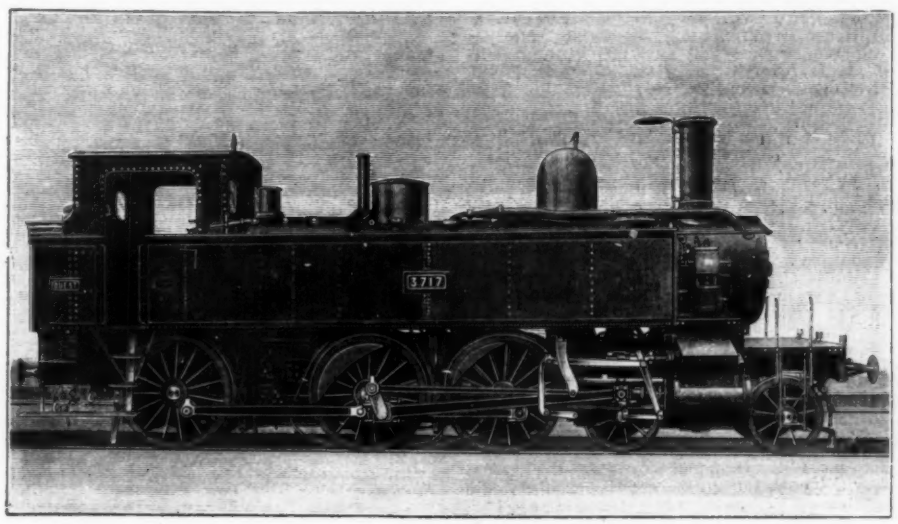


FIG. 5.—TENDER ENGINE WITH SIX COUPLED WHEELS AND A BOGIE.

The distributing mechanism is of the Walschaert system, and is made of cemented and tempered iron. The slide-valves are of bronze and of the ordinary type. The admission is variable, at the will of the engine-

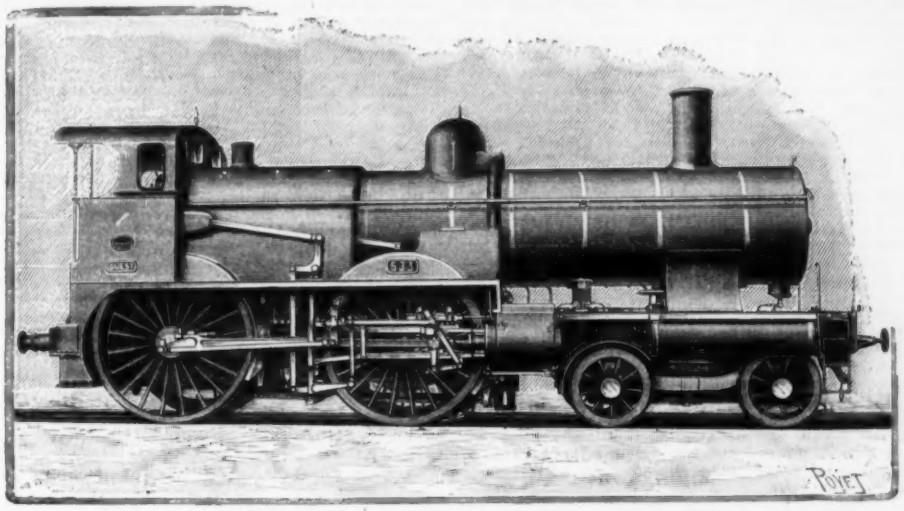


FIG. 4.—COMPOUND LOCOMOTIVE FOR FAST TRAINS.

The pistons have a stroke in common of 0·64 m. The diameter of those of the high-pressure cylinder is 0·35 m. and that of those of the low-pressure one 0·55 m., say 2·47 as the ratio of the volumes. The cranks which are actuated by the two high-pressure cylinders are keyed at right angles. The same is the arrangement with the cranks controlled by the low-pressure cylinders; but, considered on the same side of the engine, the two cranks are so set that the low-pressure one precedes the high-pressure by 162° in the direction of the normal revolution. The volume of the intermediate reservoir, inclusive of the escapement pipes of the small cylinders, and the steam-boxes of the large ones, is twice that of the small cylinders. This reservoir is provided with a safety valve regulated to a pressure of 6 kg. In order to facilitate starting, a special port permits of sending live steam to the reservoir, and a mechanism controlled by a small motor permits at the same time of sending the steam that comes from the small cylinders directly to the exhaust pipe.

man, in the two groups of cylinders, either simultaneously or successively.

The frame is formed of two simple sole bars of steel. The boiler is secured to the frame by the front, and slides upon its other supports.

The cranked axle resembles that of the Worsdell type. The truck is mounted upon wheels 1·04 m. in diameter, with axles spaced 2 m. apart. The sand-box is of the Gresham system, and the brake is of the Wenger type. The capacity of the tender is 15,800 liters. The coal bunkers contain 4,000 kg.

A few modifications will be introduced into this type in ten engines that the company will put in service before long. The register of the boiler will be increased to 15 kg. and the length of the smoke-box will be increased to 2 m. The brake will be of the Westinghouse system, and the engine will carry a brake cylinder.

COMPOUND LOCOMOTIVE WITH FOUR CYLINDERS AND THREE COUPLED AXLES.—This engine is built for the section between Toulouse and Pau, on which there are gradients of from 15 to 16 mm. to the meter, and one even of 0·032 m. of a length of 11 km. It hauls a load of 125 tons over this gradient of 32 mm. at a speed of 30 km. an hour. Upon the easier parts of the line, this locomotive frequently attains a speed of 100 km. an hour. In addition to the ease with which this engine adapts itself to the exigencies of speed, it hauls freight trains of 600 and 700 tons at 40 km. an hour.

This type is, therefore, adapted for hauling not only heavy express trains, or for running upon broken profiles, but, if need be, of hauling fast freight trains of heavy tonnage.

The general arrangement of this locomotive differs but little from that of the type previously described. The boilers are alike, the cylinders are of the same dimensions, and the distributing parts are almost identical. The differences to be noted are: (1) six coupled wheels; and (2) a rear axle simply coupled and located under the furnace.

COMPAGNIE DE L'OUEST.—The locomotives exhibited at the Vincennes annex by the Compagnie des Chemins de Fer de l'Ouest are three in number: (1) A compound express engine, with four coupled wheels and a bogie, series 500, type 1899–1900; (2) an express engine with two equal cylinders, four coupled wheels and a bogie, series 900, type 1889, constructed like the preceding in the company's own shops; and (3) a tender locomotive with six coupled wheels and a bogie, series 3,700; constructed at Creusot. These engines were elaborated under the direction of M. Clerault, engineer-in-chief of rolling stock and traction of the Chemins de Fer de l'Ouest.

HIGH-SPEED COMPOUND LOCOMOTIVE, TYPE 1899–1900.—This locomotive was constructed with a view to

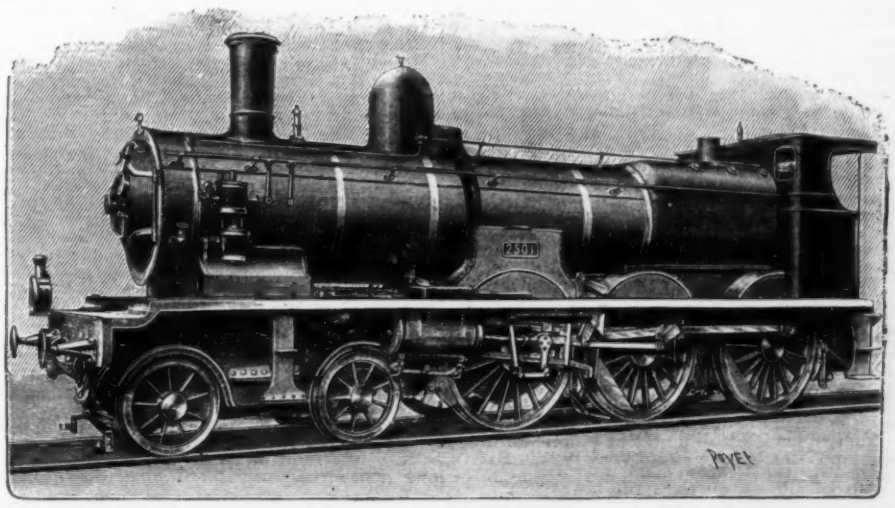


FIG. 6.—COMPOUND ENGINE WITH SIX COUPLED WHEELS AND A BOGIE FOR HEAVY FREIGHT AND PASSENGER TRAINS.

hauling trains of 250 or more tons at a speed of from 95 to 100 kilometers an hour over the principal lines of the system. It is supported in front by a bogie truck having a lateral displacement of 40 mm., and behind by two pairs of coupled wheels 2·01 meters in diameter, the first of which is placed under the cylindrical body in front of the fire-box, and the second under the back part of the furnace.

The steel sole-bars, which are on the inside of the wheels, are stayed on the one hand by the drag-bar and the cylinders, *B P*, and on the other by cross-bars or by cast steel compartments placed to the right of the cylinders, *H P*, as well as in the front and rear of the fire-box. The engine is supported at three points, and a system of plate springs and side-bars oscillating upon knife edges of hard steel assures the invariability of the distribution of the weight supported.

The bogie, which has interior sole bars and two pairs of wheels 0·96 meter in diameter, of the well known model of the Compagnie de l'Ouest (type 1889), is characterized by its great length, by a special arrangement of the pivot placed slightly to the rear of the center of the bogie, and by a particular arrangement that permits of a transverse motion (through a slide), with a regulation by connected springs. The pivot, step bearing and slide of the bogie are of cast steel.

The motive mechanism is of the compound type of 4 cylinders with plane slide valves of bronze, and of the ordinary type. The two high-pressure cylinders, which are 340 mm. in diameter and placed outside of sole bars, between the first pair of driving wheels and the bogie, actuate the axle, *A R*. The two low-pressure cylinders, which are 530 mm. in diameter and placed above the bogie, under the fire-box, actuate the axle situated in front of the latter. The stroke of the pistons is 640 mm.

The distributions of the two valve gears of the Walschaert type are controlled by the same reversing handwheel, which permits of maneuvering them in unison or separately. Upon the pipes that connect the cylinders, *H P*, with the cylinders, *B P*, are interposed cocks that permit of isolating the two groups of cylinders and of running at a pinch with separate mechanisms. These isolating cocks are controlled at a distance by the engineman through an air cylinder.

The steel boiler, which is registered at 14 kg. and has a prolonged smoke-box and a hopper for the riddance of the cinders, contains 96 Serve flange tubes 70 mm. in external diameter. A special cock placed in front of the boiler permits of the clearance of the steam tubes. The boiler is supported in front by a cradle cast in a piece with the low-pressure cylinders, and, to the right of the fire-box, by angle iron slides resting directly upon the sole bars. It is maintained transversely by a steel guide riveted upon the face, *A R*, of the fire-box. The furnace, which is of copper and of the Belpaire type, is provided with a brick arch. The total heating surface is 133·9 square meters, 11·1 square meters of which is for the furnace. The grate surface is 2·4 square meters.

As accessory apparatus, we may mention two injectors of the Friedmann vertical type, two valves of the Lethuiller-Pinel type placed upon the fire-box, Bourdon telesco-pumps for the cylinders and slide valves, a steam sand-box of the Gresham type, etc.

The engine is provided with a Westinghouse brake. Its weight in running order in a mean state of wear is 50 tons, of which 15·8 rests upon each of the coupled axles and 18·4 upon the bogie.

HIGH SPEED LOCOMOTIVE, TYPE OF 1889.—Engine 951 is the first passenger express one with a lateral and transverse moving bogie that has run in France. Since the Exposition of 1889, at which it figured, it has traveled more than 500,000 km. in ten years without any other important repairs than the replacing of the bundle of smooth tubes by one of the Serve system. During the course of the official experiments that took place in 1889 upon the Lyons system, this engine ran at a speed of 138 km. an hour, with a perfect stability upon a good track.

The company owns sixty engines of this type with equal cylinders of 460 mm. diameter (piston stroke, 660 mm.), and which includes 4 coupled wheels of 2·01 meters, with distributing side levers and a bogie in front. The boiler, which is of steel and registered at 12 kg., contains 95 Serve flanged tubes. The grate surface is 2 square meters and the heating surface is 123·4 square meters, 10 of which is for the furnace. The adhesion weight is 28 tons, and the load upon the bogie, 16·5.

SIX-WHEELED TENDER-ENGINE.—The tender-engines, with six coupled wheels and a bogie, are provided with two equal cylinders, 460 mm. in diameter (piston stroke 600 mm.), and are designed especially for use on lines with a broken profile and for hauling heavy suburban trains. Although constructed for hauling trains at a speed of 90 km. in service, they are, nevertheless, capable of running under proper conditions of stability at speeds that have reached, in experiments, 115 km. an hour. The engine, which has an internal frame, is supported in front by a bogie and in the rear by three pairs of coupled wheels, 1·54 meters in diameter, two of which are placed in front under the cylindrical body, and the third in the rear of the fire-box.

The construction of the boiler, which is registered at 12 kg., is identical with that of the engine of series 500, described above. The same is the case with the staying of the steel sole bars, with the suspension, with the fire-box, with the boiler tubes, and with all the accessory apparatus, such as valves, injectors, sand-boxes, lubricators, brakes, etc.

The total heating surface is 131·66 square meters, 9 of which is for the fire-box. The grate surface is 1·8 square meter.

The water tanks (7 cubic meters), placed above the coupled wheels, rest upon the frame through the intermedium of cast steel slide supports and four cast steel brackets, two to a tank.

The weight of the locomotive in service, in a mean state of wear, is 58·9 tons, 43·9 of which are carried by the coupled axles and 15 by the bogie.

Aside from the engines exhibited at Vincennes, the Compagnie de l'Ouest presents at the Champ de Mars some drawings of a compound engine (series 2501–2540) with 4 cylinders, 6 coupled wheels, 1·72 meter in diameter, and a bogie (Fig. 6) designed for hauling heavy passenger and freight trains, and capable also of being employed for the traction of very fast trains. This model, the primitive type of which was studied by M. De Glehn, superintendent of the Société Alsacienne de Constructions Mecaniques, was quickly adopted by several companies, with adaptations to meet the exigencies of each system.

Finally, the Compagnie de l'Ouest is just now constructing ten engines belonging to this type, but having larger wheels, so as to render it possible for them to furnish a greater speed upon the level portions of broken lines.

For the above particulars and the engravings, we are indebted to La Nature.

ORIGIN OF MONAZITE.*

By ORVILLE A. DERBY.

SOLUBILITY in Acids.—In order to test the relative solubility of the mineral in different acids a sample of monazite sand from Prado, Bahia, was freed from all admixture by careful picking, and after grinding, was submitted in parcels of about ½ gramme each to the action of 100 centigrammes of the ordinary laboratory acids, each diluted with one part of water. After standing for 68 hours without heating, phosphoric acid was determined in each solution as follows: In nitric acid solution, 2·51 per cent.; in hydrochloric acid, 1·62 per cent.; in sulphuric acid, 1·39 per cent.

Magnetism.—In cleaning up residues with the electro-magnet, it has been found that monazite can be quite successfully separated from its usual associate, zircon, and that when monazite and zenotime occur together the latter can, by a proper graduation of the points, be almost entirely drawn away from the former. In one case in which the instrument had been used with an opening between the points of about a centimeter, for the separation of pyroxine of the acmite type, which may be presumed to carry about 30 per cent. of iron oxide, a mixed sample of monazite and zircon was very neatly and quickly separated without reducing the distance between the points, both minerals being equally free from iron staining or inclusions.

Microchemical Reactions.—A single granule of the mineral, no matter how minute, can be rapidly and securely identified by moistening it with sulphuric acid on a slip of glass and burning off the acid over a spirit lamp. The characteristic crystallization of cerium in double ball-shaped clusters or radiating needles or minute cucumber seed shaped isolated crystals, can usually be detected after this operation in the ring of evaporated material about the granule, but better after adding a drop of water and allowing it to evaporate in a desiccator. Another drop of water with a slight admixture of ammonium molybdate solution added to the same preparation gives an evaporation a very satisfactory reaction for phosphoric acid. The reagents are best applied by means of a small loop on the end of a very fine platinum wire, and an excess should be avoided, especially with the acid, as too large a drop is liable to run in a very annoying manner in the heating. The same reactions are given by the recently discovered cerium-aluminium phosphate, florencite of Hussak and Prior, but this can be distinguished by its form and cleavage when these are recognizable. The microcrystalline forms of cerium and yttrium sulphates are so similar that a confusion with zenotime is also to be guarded against. It has recently been found also that soluble silicates containing zirconium give very similar forms in the sulphuric acid test, but these are readily distinguishable by the absence of phosphoric acid. Confirmatory tests with oxalic acid have not proved uniformly successful and can usually be dispensed with. The Florence test by crystallizations in a blowpipe bead requires from half a dozen to a dozen grains of the usual size and is more successful with the salt of phosphorus than with the borax bead, in which the presence of phosphoric acid appears to exercise a disturbing influence, although with patience the crystals characteristic of cerium can be obtained. When, as is usually the case, the grains are transparent, the micro-spectroscope will also usually give a very satisfactory test on a single grain of the usual size, by means of the absorption band of didymium. This can also be obtained by either reflected or transmitted light with an ordinary hand, or rainband, spectroscope, when a number of grains can be brought close together in balsam on a microscopic slide.

Natural Etching.—The grains of monazite from decomposed pegmatites or muscovite granites are frequently etched, though not to the point of completely obliterating their original form and faces, but the phenomenon has rarely been observed in the decomposition products of other types of rocks. In a miner's residue from the Cavallo Morto (Dead Horse) diamond mine near Diamantina, the extraordinarily abundant monazite grains (the mineral is lacking or rare in the residues of most of the mines of the district) are extremely fresh in appearance, presenting a strong contrast with the well worn aspect of the associated zircons, and under the microscope this difference is seen to be due to the profound natural etching of the grains. The deposit is reported by a competent observer to be a decomposed metamorphosed conglomerate like others of the vicinity, and in this case the monazite grains should be equally worn with those of zircon. On the contrary, however, they have been completely rejuvenated in appearance, and among thousands passed in review under the microscope, none showing what could be positively identified as original or worn faces were seen, except when, as in the case of the latter, these had been protected by the secondary enlargements described below. In similar deposits in the neighborhood in which the cement of the ancient conglomerate was evidently highly argillaceous, a similar etching of the included quartz grains is almost universal and is often very beautiful.

Secondary Enlargement.—In the above-mentioned residue from the Cavallo Morto mine, many grains show a darker central portion surrounded by perfectly clear material having the same optical orientation, but, like all the grains of the residue, without distinct crystalline form. The appearance is that of a rounded and worn grain with secondary enlargements principally in the form of clusters of spindle-shaped prolongations of the two poles of an original ovate grain. So far as can be made out from the color and from rather unsatisfactory optical tests, the clear outer shell is of monazite material, and this conclusion is apparently confirmed by microchemical tests, since grains in which the central nucleus appeared to be entirely protected from the action of the acid gave very satisfactorily the cerium and phosphoric acid reactions. As there was a possibility that the enlargement might be the newly discovered cerium-aluminium phosphate, florencite, which, when the form is not distinct, is readily confounded with monazite, a small quantity of the residue was tested by wet analysis for alumina, but with a negative result. It seems thus tolerably certain that in the clastic rock from which the residue comes there had been a new formation of monazite such as had been shown for tourmaline and several other minerals in similar rocks. The main objection to this conclusion is that monazite, as an antigenetic element, is thus far only positively known in rocks of eruptive or presumably eruptive origin, but this objection is weakened by evidence presented below indicative of a possible secondary origin.

Inclusions.—The monazite thus far extracted from granites, gneisses and porphyries, and that found in secondary deposits derived from these rocks, is free from inclusions, and in these cases the mineral, together with the associated accessories (zircon, magnetite or ilmenite, or both, and occasionally the phosphates zenotime and apatite), has evidently been one of the first to crystallize out of an eruptive magma. Quite recently, however, evidence has come to hand that it may also be formed in other ways and probably by secondary processes. In addition to the secondary enlargements above noticed, which were evidently formed in a metamorphosed clastic rock, the following cases have been noted: From the residues of diamond washings at Sao Joao da Chapada and Sopa, near Diamantina, and from a gold washing at Bandeirinha, in the same neighborhood, the monazite crystals of peculiar prismatic habit described in a recent number of The Am. Jour. of Science (vol. vii., page 353) are frequently found heavily charged with scales of hematite and more rarely with minute needles and grains of rutile. This type of monazite has been traced home to some peculiar schists of the region that are presumed (in part on the evidence of the perfectly fresh condition of the monazite crystals) to be of eruptive origin. In the schists from Sopa and Sao Joao da Chapada, which are almost purely sericitic, the monazite is free from inclusions, but in the chlorite-cyanite schist from the Serra do Gigante the monazite, like the accompanying chlorite and cyanite, is full of minute grains of rutile, and no essential difference in the character and mode of occurrence of the inclusions in the three minerals can be detected. Whatever may have been the original nature of this rock, the silicate elements and the rutile are clearly secondary, and there is no escaping the conclusion that the monazite must be so also. In a small gold-working called Ogó, a few hundred meters away from the great diamond mine of Sao Joao da Chapada, monazite of the ordinary type occurs with rutile in the peculiar partings, composed almost exclusively of bright green muscovite, of a quartz vein in diabase. The crystals are here of the type known as turnerite, and both they and the associated muscovite and rutile closely resemble those of the microscopic residue obtained from a specimen of the Binnenthal gneiss faced on one side with the well-known microscopic crystals of that locality. In the case of the Brazilian crystals, however, rutile and muscovite are included in them in such a way as to show contemporaneous crystallization. The rock is a peculiar one, and in its present condition may be suspected to be a secondary product, but this cannot be proved. A decomposed massive quartz-muscovite rock from the same mine, which in appearance is of the same nature as the partings, except for being finer grained and more quartzose, did not give monazite. The exposure is unsatisfactory, and as in the field examination the greenish rock was taken to be a chloritic alteration phase of the diabase, no special attention was given to it beyond taking a specimen that quite unexpectedly proved of great interest. The quartz vein, with its peculiar micaceous accompaniment, suggests a comparison with the quartz-kaolin (pegmatitic?) veins of the same vicinity, and may be suspected to be a special type of granitic apophyses. If the possibility of a secondary formation of monazite be admitted, a more plausible explanation than that given in the paper above cited (that of an intimate interlamination of eruptive and clastic material) can be given for the micaceous partings and selvages of the Sopa quartz veins that afford perfectly fresh monazite mixed with well-worn zircons.

Occurrence in Basic Rocks.—Up to a very recent period the rule seemed to be very firmly established that it was useless to look for monazite as an antigenetic element in any but highly acid rocks. In the scores of rocks examined, both sound and decomposed, it had been found to be almost universal in the muscovite granites, or their porphyritic and gneissic equivalents; frequent in the biotite granites, but lacking in the amphibole granites and all other more basic rocks that had been examined. The monazite-bearing schists above mentioned from Sopa, Sao Joao da Chapada and Serra do Gigante, however, indicate that this rule is not general, though as the type of mineral that they present is peculiar and perhaps of secondary origin, it may be that it only requires to be somewhat modified rather than set entirely aside. The Sopa schist (that one free from zircon) has not been analyzed, but it is evidently composed almost exclusively of sericite, and there is no difficulty in considering it as a modified porphyry. That of Sao Joao da Chapada, though basic in the low silica (37·77 per cent.) and high iron (28·36 per cent.) contents, may be plausibly considered as a basic phase of a mixed dike of essentially granitic character. No such hypothesis is, however, possible with the Serra do Gigante schist with its 38·32 per cent. of silica, 28·16 per cent. of alumina and 12·04 per cent. of magnesia. As already stated under the head of inclusions, all the elements of this schist are apparently secondary, and it might therefore be considered as a metamorphosed sedimentary clay. The high percentage of magnesia is, however, anomalous for such a clay, and in the preceding paper, in which this rock is more fully discussed, the hypothesis of the decomposition and leaching, prior to metamorphism, of an original eruptive rock is suggested. Even so, however, it seems necessary to imagine a type of eruptives that has not yet been clearly recognized, though there are indications of its possible existence.

* From The American Journal of Science.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

Ibero-American Congress at Madrid.—I have to report that on the 10th instant, an Ibero-American congress was inaugurated at Madrid, under the presidency of the Spanish Ministers for Foreign Affairs, who made speeches welcoming the representatives of the Spanish American republics to the congress, says Consul-General Julius G. Lay, of Barcelona.

Without touching on the sentimental element in most of the inaugural speeches, I will endeavor to briefly outline the scope of this meeting of the representatives of the various Spanish-speaking countries. On the part of the Spanish delegates, their aim and object is to open the South American markets to Spain's products, and the following are some of the proposals that are being discussed:

(1) The establishment of free ports, or "zones," at Barcelona and other Spanish ports, with the object of facilitating the export trade to South America. The former has been practically decided upon already.

(2) The formation of an international bank, either with branches in the various Central and South American republics, or with close connections with the banking firms already established and of long standing.

The capital of this bank, it is calculated, should not be less than 30,000,000 pesetas, and should be raised partly in Spain and partly in South America. Some difficulty is anticipated in obtaining the required capital, owing to the doubtful returns that may be expected during the first few years of its existence, especially as the Spanish state securities pay 4½ per cent. interest to investors. The Spanish government is therefore to be asked to guarantee a certain small annual interest, in consideration of the important advantages that will be derived by Spanish trade from the formation of such a banking concern.

(3) In order to more easily come to an exclusive commercial understanding with the Ibero-American states, the question will be discussed of the advisability of suppressing the favored-nation clause in all treaties to be made involving any special advantages that may hereafter be mutually conceded by Spain and the Spanish republics. This precedent has already been established in Spain's treaty with Switzerland, for in article 5 the advantages granted by Spain to Portugal or to Spanish American republics are excluded. Portugal, also, in its treaty with Spain, excludes the special concessions made to Brazil. The favored-nation clause that exists in all the treaties between the Spanish American states and European nations it is claimed hinders the development of commercial relations between the former states, inasmuch as the smallest concession granted to any of their neighbors is immediately claimed by all other nations.

(4) An international copyright among all Spanish-speaking countries is to be proposed, with a heavy import duty on all books printed abroad in the Spanish language.

(5) State-regulated emigration agencies, to stop the indiscriminate emigration of the working classes to countries having nothing in common with the Spanish race, supported by private societies at all the different foreign ports of arrival, to look after and assist the immigrants in the Spanish-speaking countries.

(6) Formation of commercial museums in all the chief cities of South America and reduction in railroad and steamship fares, besides other facilities to commercial travelers.

(7) Improvements in the postal service between Spain and Central and South America and establishment of a parcel post. The laying of a cable between Spain and South America is also to be advocated, and the governments of the countries concerned are to be asked to consider the question of establishing a uniform currency.

American Meat in South Africa.—In a report from Birmingham, England, under date of June 25, 1900, Consul Halstead quotes the following from the Sydney correspondent of Sell's Commercial Intelligence:

"Advices from South Africa state that the British and Colonial troops prefer Australian meat to that imported from America; consequently, large orders have been placed with colonial houses. . . . The American tinned meats are declared to be inferior in quality to the Australian commodity, but Americans in Melbourne and Sydney hint at the possibility of a quantity of low-grade goods having found their way into the South African market. There has certainly been a lot of rubbish sent thither, a matter to which the United States consuls will probably give some attention."

The Sydney correspondent naturally stands up for home enterprise and home industry. Not having heard any complaint of the American tinned meats, the statement above was somewhat startling, and I at once addressed a letter to an army official who is in a position to know, asking for data as to the quantities of American and Australian meat consumed in the country, and inquiring if any preference had been expressed by the consumers. He replies as follows:

"The preserved meat, both of Australian and American manufacture, has been found generally to be of good quality, and I have not heard of any marked preference being shown by the troops for one over the other. The only exception has been in the case of —— brand, which, after examination, was pronounced by the army medical authorities to be good, but to contain an excess of salt. The examination was made in consequence of complaints from army headquarters at Modder River, in February last, of the meat being too salty and causing undue thirst. Great inconvenience has been caused by the meat, in some cases, being canned in 6-pound tins. One-pound or at most 2-pound tins are the largest that are suitable for active service. When a man is carrying a 6-pound tin of meat—i. e., a day's ration for himself and five comrades—and anything happens to separate that man from his comrades, they are liable to lose their ration of meat. If the tin is opened and the contents divided, the meat becomes very unpalatable before being eaten, unless consumed at once."

I have also made inquiries of the representatives of the export commission houses who place orders in the United States, and of jobbers or wholesalers who make bids, give the orders to the export commission houses, and supply the trade and the army. Not one has heard of any fault being found with the quality of the American product. On a recent trip to the Transvaal, I partook of both kinds of tinned meat at stations where the train was delayed, and while I noticed that the American meat was found more frequently than the other, I heard no complaint of either. Two carloads were destroyed by the Boers who attacked the train, and the loss was deplored by the officials, who said it was "too bad to lose so much good meat."

Australian tinned meats are lower in price than ours; they cost $2.20 per dozen 2-pound tins, and the American $2.50.

I would again call attention to the canned-salmon trade of England. Fresh salmon is worth in England 2s. 6d. (60 cents) per pound. Thousands of cans of Alaska salmon are exported from the United States to England, rebranded, and sold as English salmon at an advance of from 6d. to 8d. (12 to 16 cents) per dozen tins. The same may be said of ham. I am informed that nine-tenths of the well-known English hams are of American production, cured in England. Not until the United States manufacturers insist upon their own brands being placed on tins of salmon, and export hams cured to suit foreign taste, will they derive the benefit that is their due.—J. G. Stowe, Consul General at Cape Town.

Antwerp Ivory Market.—The fourth quarterly sale of the year was held on October 30 and 31 last, the ivory offered for sale and sold being as follow:

	Pounds.
Kongo.	
Hard	136,544
Soft	10,963
Angola	15,612
Kamerun	14,574
Gaboon	4,032
Abyssinian	3,220
Mozambique	2,306
Zanzibar	1,878
Senegal	178
Total	189,307
Hippopotamus tusks	205
Rhinoceros tusks	48
Divers curiosities	440
Total	190,000

The totals for the corresponding quarter of preceding years were:

	Pounds.
1899	169,050
1898	110,230
1897	165,345
1896	132,276
1895	156,526

On the first day of the sale, the prices paid for heavy and medium weight tusks were 38 cents under the average and for the light tusks and scrivailles of good quality 19 cents. The demand for the poor qualities was particularly small, and the prices fell by 57 cents; while the tusks for bangles and balls were in strong demand, the prices paid being good. On the second day, the prices paid for ivory of the Kongo, Angola, and Kamerun variety showed an increase of about 9 cents per kilogram (2,046 pounds), over those of the preceding quarterly sale.

The stock on hand at present amounts to about 238,176 pounds, as compared with 259,971 pounds in 1899, 176,368 pounds in 1898, 134,480 pounds in 1897, and 136,685 pounds 1896.—Geo. F. Lincoln, Consul-General at Antwerp.

Rise in Coal Prices in Australia.—Under date of October 1, 1900, Consul-General Bray, of Melbourne, sends an article from The Melbourne Argus of September 29, 1900, on the rise in the price of coal and the effect upon the manufacturing industries of Victoria, as follows:

In accordance with an anticipation expressed at the meeting of the colliery proprietors of Newcastle on the 20th instant, it has been decided to raise the price of coal from January next to 11s. ($2.67) per ton, instead of 10s. ($2.43) per ton, as previously agreed upon. The advance will be the substantial one of 3s. (72 cents) per ton, or 37½ per cent. on the present price of 8s. ($1.94) per ton. Under the agreement, the miners will get 4d. (8 cents per ton) of the extra 1s. (24 cents) now agreed upon. The action taken by the colliery proprietors must, of necessity have a far-reaching and disastrous effect upon all those industries in Victoria which depend upon coal for the output of their various manufactured articles. At present, the greater part of the coal for factory purposes imported from Newcastle to Melbourne costs about £1 ($4.86) per ton, and the increase in the price at the pit's mouth in January next will bring the price up to £1 3s. ($5.58) per ton. In view of the steady increase in the consumption of coal in Victoria and the additional factories and workshops which are everywhere springing into existence under the stimulus of the approaching federation of Australia, the loss to Victoria manufacturers will be very severe, and, in the opinion of experienced commercial men, many of the smaller capitalists will be obliged to close down their works altogether. During the six months ended June 30, 1900, the quantity of coal imported into Victoria was 370,465 tons, while for the corresponding period of last year the quantity was 270,881 tons. The total export of coal for the half year from New South Wales was 1,383,000 tons, of which 884,000 went to intercolonial ports, while 498,000 went into foreign markets. In consequence of the war and of the greatly enhanced price of coal in England, the foreign demand for Newcastle coal is increasing, and coal owners are not obliged to look only to the local market. But if the price is raised much more, it is contended by competent authorities that many of the struggling industries of Victoria will be destroyed and will cease to be consumers of coal from New South Wales altogether.

American Coal for Russia.—Consul Bartleman, of Geneva, on November 2, 1900, sends the following clipping from The London Daily Mail of even date:

Coal is so scarce in Russia and there is so little to be had near at hand that America is being called on to supply the deficit.

The demand for coal and fuel of all kinds, says the British commercial agent at St. Petersburg, still increases every day and prices rise accordingly. Foreign coal may be imported free until July next, and there seems every likelihood of an indefinite prolongation of this free trade in coal. The government will also grant loans to new colliery companies.

In July last the British steamer "Accomac" landed at Cronstadt the first cargo of coal ever landed there—3,074 tons of New River steam coal shipped by the Chesapeake and Ohio Coal Agency Company. The use of peat fuel is occupying official attention.

Utilization of Furnace Gas in Germany.—Vice Consul-General Hanauer, of Frankfort, writes, November 3, 1900, as follows:

On October 30, twenty-five representatives of the largest iron works in France and Belgium visited the Hörde Mining and Rolling Mills Association, at Hörde, near Dortmund, Prussia, to inspect the electrical central station for utilizing the gas coming from the mouths of furnaces. This new method is considered one of the wonders of modern technics. The plant, when fully completed, will have a force of 6,400 horse power. At present three twin motors of the Oechelhaüser's system are run by this furnace gas to produce an electric current for supplying power and light for the Hermann rolling mills. A fourth motor of 600 horse power and four others of 1,000 horse-power each are now in process of construction to serve like purposes.

Abolition of Free Ports in Eastern Siberia.—Commercial Agent Greener reports from Vladivostock, October 10, 1900, that, according to a recent decree, all foreign merchandise coming into the ports at the mouth of the Amur River and into the ports south of it, as well as that coming overland from abroad, shall, from January 1-14, 1901, pay the duty now levied in European Russia. An exemption is allowed on all Chinese products brought by land across the boundary, with the exception of tea and alcoholic liquors. The following articles are to remain free of duty: Cereals in grain, potatoes, beans, vegetables, fruits, Chinese nuts, bean oil, beef, salt, cattle, and the like; also, building and paving stones, clay, bricks, potter tubes, coal, belting for machinery, metal sieves, sulphur, borax, cast iron, iron, boilers, cisterns, dynamo-electrical apparatus, agricultural machines, and the like; also, carbolic acid and all other apothecary drugs.

Cotton Crop of Central Asia.—Writing under date of November 6, 1900, Vice Consul Smith, of Moscow, states that the cotton crop of Central Asia, according to calculations based upon the area sown, is expected to be excellent this year. In many instances, as for example in the Ferganasky districts, the area of the sown cotton fields has increased over 30 per cent., and in some of the other districts even more. Last year's demand for cotton amounted approximately to 15,000,000 poods (240,395 tons), of which about 6,000,000 poods (96,774 tons) came from central Asia. This year's crop is expected to be between 7,000,000 and 8,000,000 poods, or enough to meet half of the general demand. The remaining cotton required for manufacturing purposes in Russia will have to be imported.

New Railway Service between Moscow and Baku.—Vice Consul Smith writes from Moscow, November 6, 1900, as follows:

A special express train running between Moscow and Baku made its first trip on the 28th of October last, leaving per the Moscow-Kasa Railway station. The train consists of one first-class car, two second-class cars, and one baggage car. These cars are constructed, according to the most recent models, on Pullman trucks, and are fitted with the latest improvements. They are of Russian make and were built at the shops of the Vladikavkaz Railway. Special attention has been given to the comfort of the passengers. The average speed of this train will be 58 versts per hour, which is equal to 40 miles.

Italian Demand for Coal Pitch.—The Bureau of Foreign Commerce has received a letter from Mr. J. P. Spanier, 160 Corso Umberto I°, Rome, dated November 6, 1900, asking to be put in communication with some responsible firms in the United States who can offer full cargoes of pitch extracted from coal, to be used in the manufacturing of patent fuel. Considerable business, he says, can be transacted if connections are made with the proper party.

Coal Discoveries in Austria-Hungary.—Consul Hughes, of Coburg, writing under date of October 31, 1900, says he has been informed from reliable sources that a very large deposit of so-called "house coal" has been discovered at Barmocz, in Hungary. This deposit, estimated to contain at least 1,600,000,000 tons, is to be developed on scientific lines at once, arrangements having been made to deliver to the railroads from 400 to 500 truck loads per day at a very early date. The quality of this coal, of course, remains to be proved. Another field is also said to have been discovered in Bohemia, but very much smaller in size and of poorer quality, which is, however, to be developed in the early part of next year if the necessary arrangements can be made.

INDEX TO ADVANCE SHEETS OF CONSULAR REPORTS.

No. 907. December 10.—Development of the Zurich Tramways—Ocher in Germany—German vs. United States Trade in Australasia—Copper Exports from Tasmania—*Wool Sales at Melbourne—*Railway Contract in Nicaragua.

No. 908. December 11.—*Ibero-American Congress at Madrid—*Medical Degrees in Germany—*Conditions in the German Iron and Steel Market—*Thread and Cloth Mill Concession in Nicaragua—*New Bank in Asuncion.

No. 909. December 13.—Electric Tramways in Barcelona and Vicinity—Establishment of a Free Zone near Barcelona—Sanitary Treaty between Argentina and Uruguay—Coal-Mining Company in Liberia.

No. 910. December 14.—*Electrical Industries in Bangkok—Peruvian Steamship Company.

No. 911. December 15.—Wool Scouring in France—French Wool Industry—*American Steel in Germany—*Tariff Protection for German Boot and Shoe Industry.

The Reports marked with an asterisk (*) will be published in the SCIENTIFIC AMERICAN SUPPLEMENT. Interested parties can obtain the other Reports by application to Bureau of Foreign Commerce, Department of State, Washington, D. C., and we suggest immediate application before the supply is exhausted.

WIRELESS TELEGRAPHY.

WITH the exception of the unpublished experiments of Prof. Hughes, nothing seems to have been done in the way of utilizing Hertzian electric waves for the purposes of telegraphic communication before the year 1895.

In April of that year, Prof. A. Popoff, of the Cronstadt Torpedo School, described to the Russian Physical Society the apparatus shown in Fig. 1, which he

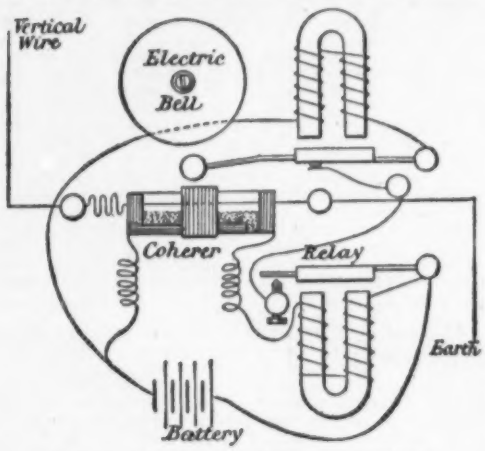


FIG. 1.—POPOFF'S HERTZIAN WAVE RECEIVER.

employed as a receiver for Hertzian waves. It consisted of a tube coherer built in two sections, and having one of its terminals connected with a vertical wire, and the other with the earth. When a wave fell upon the coherer, causing its resistance to fall from an almost infinite value down to a few hundreds of ohms, a current from the battery was enabled to flow through the circuit and energize the electro-magnet of an ordinary Siemens telegraph relay, thereby closing a circuit, not shown in the illustration, containing a large battery and a telegraphic recorder, which continued in action as long as the current flowed through the battery in the coherer circuit. As soon, however, as coherence was set up, the electro-magnet of the electric bell was energized simultaneously with that of the relay, and the bell-hammer striking upon the central plate of the coherer caused decoherence, so that, unless the waves continued and re-established the state of cohesion, the recorder was thrown out of action.

Using a Hertz oscillator with 30 centimeter spheres, Popoff was able to send signals over a distance of a kilometer, which he extended to five kilometers, by replacing the Hertz oscillator by a Bjerknes one with spheres 90 centimeters in diameter.

Very shortly afterward Captain Jackson made some experiments for the Admiralty at Devonport, and succeeded in sending messages from one ship to another. His apparatus, however, and the results obtained with it, were treated as confidential and have not been published.

In June, 1896, Guglielmo Marconi, a young Italian, and a pupil of Prof. Righi, applied for provisional protection for "Improvements in transmitting Electrical Impulses and Signals and in Apparatus therefor," and filed a complete specification on the 2d of March, 1897. At the time of making his provisional application Marconi's apparatus was in a somewhat crude form, but it contained important improvements in details, and in July, 1896, he had the fortune of obtaining the assistance and support of the Postal-Telegraph Department, through the good offices of Sir W. H. Preece, who was then the Chief Engineer of the Post Office.

With this powerful co-operation, combined with his own indefatigable industry and experimental skill, Signor Marconi succeeded in overcoming a host of difficulties, and in developing a commercially practical system of telegraphy based on Hertzian electric waves.

The transmitting apparatus employed for long distances when it is not required to concentrate the waves in a definite direction is shown in Fig. 2.

The small spheres, d, d, are connected by the wires, c', c', with the secondary terminals of an induction coil,

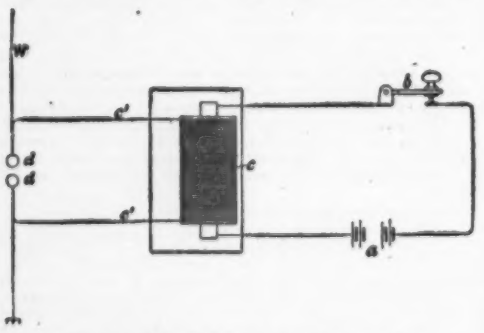


FIG. 2.—LONG DISTANCE MARCONI TRANSMITTER.

a, and one of them is also connected with the vertical wire, W, while the other is earth connected. When the Morse key, b, is depressed, the coil is energized by the battery, a, and therefore, as long as it is kept down, a stream of sparks is maintained between the spheres, d, d.

When it is desired to send a beam of rays in some definite direction, the transmitter used by Marconi is one devised by Prof. Righi, of Bologna, and shown in Fig. 3. The two large spheres, e, e, are 11 centimeters in diameter, and are separated by a space of a millimeter. In order to concentrate the beam of rays in the required direction the oscillator is placed in the focal line of a parabolic cylindrical reflector, as shown in Fig. 4.

The most important part of the receiver is the coherer, which consists of a small glass tube (Fig. 5), about two and a half millimeters in internal diameter and some four centimeters in length. Two silver pole pieces are lightly fitted into this tube, separated by a gap of about a millimeter, containing a mixture of 96 parts of nickel and 4 parts of silver, not too finely

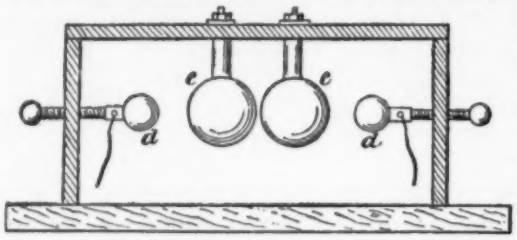


FIG. 3.—RIGHI OSCILLATOR FOR USE WITH REFLECTOR.

granulated, and worked up with the merest trace of mercury. This powder must not be packed too tight, or the action will be irregular and over-sensitive to slight outside disturbances, while if too loose it will not be sufficiently sensitive. It is found that the best adjustment is obtained when the coherer works well under the actions of the sparks from a small electric trembler placed at a distance of about a meter. The tube is then exhausted on a mercury pump until the

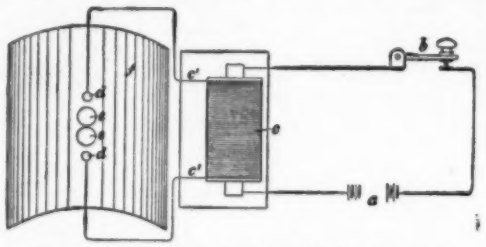


FIG. 4.—MARCONI TRANSMITTER WITH PARABOLIC REFLECTOR.

pressure falls to about a millimeter, when the tubulure left for exhausting it is sealed off. The tubes are tested over a distance of 18 miles before being put into use, and when all the requisite precautions are observed, Signor Marconi finds them as reliable as any other telegraphic instruments, and not liable to get out of order when in use. His experience in this is confirmed by that of Prof. Fleming. If the tubes are not exhausted, they are found to grow gradually less sensi-

FIG. 5.—MARCONI COHERER.

tive, probably from slight oxidation going on, and this of course would not be permissible in commercial instruments.

The general arrangement of the receiving apparatus for long distance work without a reflector is shown in Fig. 6. f, f^2 is the coherer tube, with its silver pole pieces, f^1, f^3. The coherer forms part of a circuit containing a local cell, g, and a sensitive telegraph relay. When electric waves impinge upon the coherer, its re-

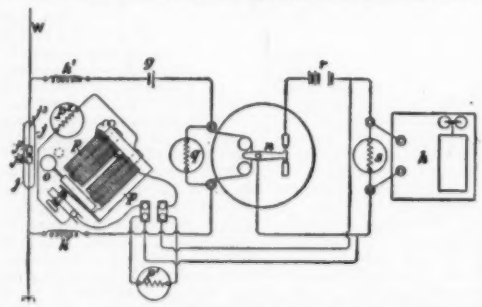


FIG. 6.—MARCONI RECEIVER WITH VERTICAL WIRE AND EARTH CONNECTION.

sistance falls from a nearly infinite value to something between 500 and 100 ohms, which allows the cell, g, to energize the electro-magnet of the relay, n, and close a circuit containing a larger battery, r, together with a Morse recorder, h, and a trembling electric bell, p, to act as decoherer. The hammer, o, of the bell is so adjusted as to tap the coherer tube and shake the filings in it. If at the moment in which these actions took place the electric waves in the resonator had died away, this tap would restore the coherer to its normal condition of practically infinite resistance, and a dot only would be recorded on the tape of the Morse machine. If, however, the key of the transmitter were kept depressed, then waves would succeed each other at very short intervals, so that the acquired conductivity of the coherer would only be momentarily destroyed by the tap of the bell-hammer, and immediately re-established by the electric waves. Now the armature of the Morse recorder is somewhat heavy, and therefore has considerable inertia, so that it cannot follow the very rapid vibrations of the tongue of the relay. The practical result, therefore, is that the Morse instrument gives an exact reproduction of the dots and dashes produced by the movements of the key at the transmitting station, although during each movement of the key, however short, the armatures of the relay and of the tapper go through a series of rapid vibrations dependent on each other.

Small choking coils, k^1 k^1—that is to say, coils wound so as to have self-induction or electric inertia—are introduced between the coherer and the relay, their effect being to compel the greater part of the oscillatory current induced in the circuit by the electric waves to traverse the coherer, instead of wasting the greater portion of its energy in the alternative path afforded by the relay. If these coils are omitted, other circumstances remaining the same, Signor Marconi finds that the distance at which the signals can be distinguished is reduced to nearly half that attained when they are employed.

In order to screen the receiver from the violent surgings which would be set up when using the transmitters at the same station, he inclosed the whole of the receiving apparatus, with the exception of the recorder, in a metallic box. As some of the waves picked up by the recorder would, by traveling along the leads into the receiver, injure the coherer, he chokes off all such effects by interposing suitable choking coils between the recorder connections and the terminals of the receiver. These choking coils consist of a few turns of insulated wire wound in layers, each layer being separated from the adjacent ones by means of sheets of tinfoil in metallic connection with the inclosing box. This earthed tinfoil prevents the waves from passing inductively from one turn of the choking coil to the next. The earthed terminal of the receiver is connected to the box and need never be touched. Signor Marconi also found that, unless provision was made against it, the relay, the tapper, and the recorder all produced disturbing effects on the receiver, but he got rid of those effects by introducing suitable non-inductive resistances, q, p^2, and s, in parallel with them, or, as telegraphists say, he shunted them with these resistances. This prevented all sparking at the contacts, and sudden perturbations, or jerks, due to the local battery current, all of which would otherwise produce disturbing effects on the coherer.

When it is desired that the receiver should only pick up waves coming in a certain definite direction, the arrangement shown in Fig. 7 is employed. This differs

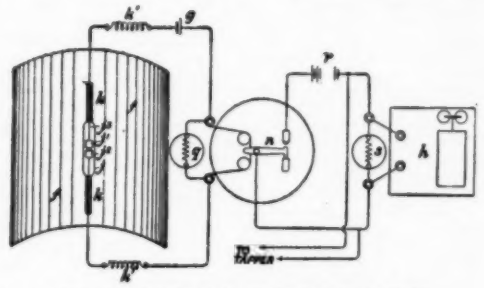


FIG. 7.—MARCONI RECEIVER WITH PARABOLIC REFLECTOR.

from that shown in Fig. 6 only in the vertical wire and earth connection being done away with, and replaced by the two copper strips, k, k, the sizes of which must be carefully adjusted so that the receiver may be in syntony with the transmitted waves; and in a parabolic cylindrical reflector being placed so that the coherer tube lies with its axis in its focal line.

My readers will observe the considerable similarity between Marconi's apparatus and that of Popoff; although I believe that, when Signor Marconi designed his apparatus, Popoff's results were unknown to him. Both used the coherer to actuate a relay, and thereby bring into action a telegraph recorder, and both used a tapper to cause decoherence. Popoff also anticipated Marconi in the use of a vertical wire and earth connection on his receiving instrument, but does not seem to have recognized its necessity on the transmitter.

The use of the tall vertical wire on both transmitter and receiver forms one of the most notable of Marconi's improvements, and the one which has perhaps played the largest part in his successful transmission of signals over long distances. A horizontal wire is no use, even if added at the top of a long vertical wire, so as to keep it at a great distance from the earth. The effect of the long wire is to increase the length of the waves generated in the ether, and, therefore, to augment their power of penetrating obstacles, the wave length being about four times the length of the wire. The reason that it acts so much better in a vertical position than in any other is that that position is the one which is least favorable to the production of induced oscillating currents in the earth, which, if set up, must dissipate uselessly the amount of energy required to excite them.

Signor Marconi finds that a conductor with considerable capacity, such as a sheet of wire net, attached to the top of the vertical wire by means of an insulating rod, is to some extent equivalent to increasing the length of the wire. He found experimentally that, if the wires at the two stations are equal in height, the distance to which signals could be transmitted was approximately proportional to the square of that height, the actual maximum distance being somewhat in excess of that calculated from this assumption. Prof. Ascoli has confirmed this result mathematically.

One of the Marconi masts, 150 feet high, which was erected at the South Foreland last year, is now of historic interest, as being the one which was used for the first transmission of messages by the new system of telegraphy between England and France, the French station being at the village of Wimereux, near Boulogne, and at a distance of 32 miles from the South Foreland. In place of using a high mast the vertical wire might, where the opportunity exists, be suspended from the top of a cliff or of a lofty building, and Mr. Marconi has in this way successfully trans-

mitted messages between Bournemouth and Alum Bay in the Isle of Wight, a distance of about 14 miles. No mast was employed at the latter station, the vertical wire being allowed to hang over the edge of the cliff, the instrument and earth connections being at the top, while the lower end of the wire, which was about 100 feet long, hung free in space, the wire being kept at a distance of about 30 feet from the face of the cliff.

I am not aware that any attempts have been made to employ the Marconi apparatus with reflectors for greater distances than two miles. Hertz found that to obtain good results with reflectors they must be large compared with the wave length, and the distance of the mirror from the oscillator must not be less than a quarter of the wave length, as clearly follows, that the emission point of the waves is a quarter of a wave length from the vibrating source.

It will be seen, therefore, that it would hardly be practicable to employ reflectors in conjunction with high masts for transmitting beams of rays in a given direction. For example, with the vertical wire 150 feet long, such as that in use at the South Foreland, the wave length would be about 600 feet. The dimensions of mirror would therefore have to be large compared with this, and placed at a distance not less than 150 feet from the oscillator.

The use of reflectors is, however, of considerable value for communicating between ships, or ships and the shore at short distances.

By the use of reflectors it is possible to project the electric waves in an almost parallel beam, which will have no effect upon any receiver not lying in its course, whether this receiver be syntonic with the waves or not. This, as Signor Marconi has pointed out, would enable several forts, hill-tops, or islands to communicate with each other in war time, without any fear of the enemy tapping or interfering with the signals, for, if the forts were on a small height, the beams could easily be directed so as to pass over any position that might possibly be occupied by the enemy.

In some experiments, made over a distance of one and three-quarter miles, Signor Marconi observed that quite a small movement of the reflector of the transmitting instrument was sufficient to stop the reception of the signals by the receiver. The zone within which the receiver had to be placed for a given position of the transmitting reflector not being more than about 100 feet in breadth.

"There exists," says Signor Marconi, in his paper read in March, 1899, before the Institution of Electrical Engineers, "a most important case to which the reflector system is applicable, namely, to enable ships to be warned by lighthouses, light-vessels or other ships, not only of their proximity to danger, but also of the direction from which the warning comes. If we imagine that *A* is a lighthouse, provided with a transmitter of electric waves, constantly giving a series of intermittent impulses or flashes, and *B* a ship provided with a receiving apparatus placed in the focal line of a reflector, it is plain that when the receiver is within range of the oscillator, the bell will be rung only when the reflector is directed toward the transmitter, and will not ring when the reflector is not directed toward it. If the reflector is caused to revolve by clockwork, or by hand, it will therefore give warning only when occupying a certain section of the circle in which it revolves. It is therefore easy for a ship in a fog to make out the exact direction of the point, *A*, whereby, by the conventional number of taps or rings, she will be able to discern either a dangerous point to be avoided or the port or harbor for which she is endeavoring to steer."

Marconi's apparatus was installed in November on board "The Princess Clementine," one of the Belgian boats carrying on the passenger service between Dover and Ostend. It is stated that the distance covered exceeded eighty miles, and that the apparatus is shortly to be supplied to other vessels belonging to the Belgian Company.

There is a difficulty which will have to be overcome if the system is to come into extensive use, and that is the interference of simultaneous messages coming from different stations, all of which would affect all receivers within range, with the result of making the messages unintelligible.

Prof. Lodge has devised and patented some interesting forms of syntonic transmitters, but, as far as I am aware, he has not yet succeeded in transmitting syntonic messages over any considerable distances. A syntonic radiator is necessarily one which produces persistent oscillations instead of having them damped out almost immediately. Now this damping out means that the ether rapidly takes up the vibrations, so that making a radiator syntonic means making it feebler.

It is stated that Signor Marconi has now succeeded in devising apparatus by which syntonic messages have been successfully transmitted to distances of over 30 miles, but as the patents are not yet completed, I am not able to obtain any information as to the methods employed.

If he can do this, it will prevent the interference above referred to, as the receiver at any station will respond only to the messages intended for it.—G. W. de Tunzelmann, B.Sc., in Knowledge.

THE PANORAMIC KODAK.

IT is possible to take panoramic views with any photographic apparatus. To this effect, it suffices to take a series of negatives contiguous to one another by displacing the apparatus each time to a degree equivalent to the angle embraced by the objective. This method, which is often employed by amateurs, presents the inconvenience of necessitating junctions between each positive print in order to obtain a general view, and these, as a general thing, it is quite difficult to conceal. Hence panoramic apparatus have been devised for simplifying both the operations of exposure and printing. The operator has no longer to concern himself with displacing the apparatus, a single negative gives the entire panorama, and the printing is done as with an ordinary negative. It was a very long time ago, it may be said almost at the birth of photography, that the idea occurred to employ to this effect an objective revolving upon an axis in front of a semi-cylindrical sensitized surface. In Blanchère's Repertorie Photographique, we find a description of such an apparatus devised by Martens in 1846. It is shown here that it is necessary to cause the objective to turn in a position such that the image shall remain stationary, and that a flexible sensitized surface such as paper must be employed; but at this epoch and for many years afterward, the substances used for obtaining sensitiveness did not permit of utilizing such an apparatus. The idea was taken up again in 1883, by M. Moessard, who, at the outset, established the principle upon which it is necessary to rely in order to obtain an immovable image upon a fixed surface with an objective in motion. For this purpose, it is indispensable that the axes around which the objective revolves shall pass through the nodal point of emergence. Such point is determined by considerations emanating from optical bars, and may be indicated by the manufacturer of the objective.

In the Moessard apparatus, flexible plates placed in separate frames are utilized as a sensitized surface.

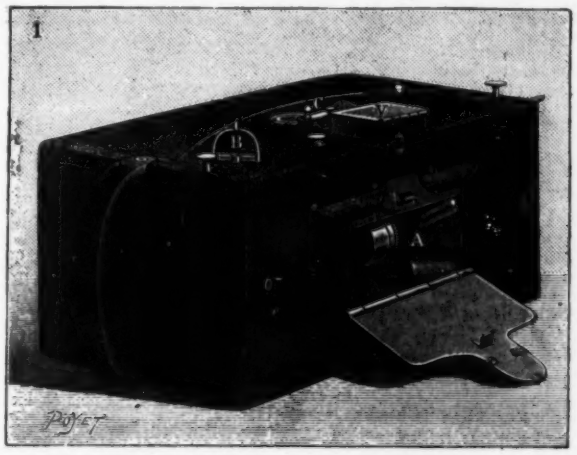


FIG. 1.—THE PANORAMIC KODAK—EXTERNAL VIEW.

The use of the apparatus is no more complicated than that of the 5·2 × 7·2 inch or 7·2 × 9·6 ones that generally serve for photography with glass plates. But the instrument is of a relatively high price, and it is with the object in view of rendering it possible for anyone to take panoramic views that the Eastman Company has recently constructed a very portable kodak based upon the same principle. This is in the form of a square box (Fig. 1) 3·6 inches in height, 4·4 in width and 7·6 in length. The objective, *A*, placed in the center of the wall having the largest dimensions, is mounted upon a pivot passing through the nodal point of emergence. A flexible piece of skin completely closes the aperture formed in this wall for its insertion, and allows it full liberty to describe a semi-circumference. It terminates in the interior of the camera (Fig. 2) in a sort of a flat chamber, *A*, so as to prevent the oblique rays from striking the sensitized surface. This latter consists of a film, *P*, wound upon a spool placed upon one of the sides of the apparatus in the interior of the camera. A second spool, *B*, placed symmetrically upon the other side, receives the free extremity of the film and serves for winding it after the negative has been taken. In its travel from one spool to the other, it passes over two arched guides which hold it above and below in such a way that, once in place, it shall present a semi-cylindrical surface having as a center the pivot around which the objective revolves. There is no shutter, since the objective itself performs the function thereof. In fact, when the latter is so arranged (Fig. 1) that its axis is in the plane of the board that serves as a support, not a ray can enter the apparatus. As it is mounted upon a spring that causes it to make a revolution of 180° around the pivot, it suffices to press the button that holds it in position in order to free it. In its travel it traverses the entire horizon, and the image, or rather the uninterrupted series of images, is depicted at the focus, that is to say, upon the sensitized surface. In order to obtain another negative, the necessary length of film is wound upon the spool. Such length is indicated by means of a figure that may be seen upon the exterior by looking through a red glass. This, however, is the same arrangement employed with the ordinary kodak. It is also the same film that is used, although two lengths instead of one are employed for each negative. The spools, which are covered with black paper, can be wound in broad daylight, as is usually the case with apparatus in which the Eastman rollers are employed. The spring that actuates the objective is tightened anew after each operation. To this effect, a handle, *C*, arranged upon the apparatus, and that may be rendered immovable in two positions, is acted upon. One of these positions is for slight speed and the other for greater rapidity. It is evident that but two instantaneous views can be obtained; but it will be remarked that we have here an arrangement of which the rendering is very great. The maneuvering is very simple, and can be effected by any amateur. The only difficulty consists in knowing how to select the subject properly. An ordinary finder, *V*, placed upon the top of the box does not give the operator much information, since it reproduces but a part of the image and gives principally an indication as regards the ground and sky of the part facing him. But, after a short time he will easily make out the image that he will obtain. It will be indispensable especially when the sun is low upon the horizon, for the operator to assure himself that it will not be opposite the objective at one point of its course, for this would produce a general fog.

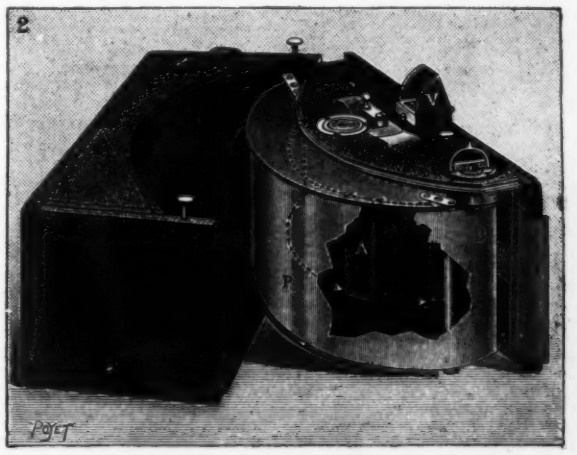


FIG. 2.—THE PANORAMIC KODAK—INTERIOR ARRANGEMENT OF THE FILM AND OBJECTIVE.

Panoramic photography presents much interest. A person realizes this when he seeks the most interesting points of a picture with an ordinary camera. Here he is certain of having all of them. That does not mean that a view of this kind can be taken in any manner whatever. There is always a certain art in knowing exactly how to place one's self; and a person must never forget that the foreground plays an important part, and so he should endeavor to have as much thereof as possible.—La Nature.

Exports from the United States to Cuba, Porto Rico, and the Philippine, Hawaiian and Samoan Islands will aggregate $50,000,000 in the year 1900, against $41,000,000 in 1899, $19,000,000 in 1898, and $17,000,000 in 1897. This enormous growth is shared by each of the islands named, but is especially apparent in the case of Porto Rico, to which the exports in the year 1900 under the new Porto Rican act will show an increase of about 50 per cent. as compared with last year, and 100 per cent. as compared with preceding years.

The above figures are necessarily estimates so far as they relate to November and December of the present year, but a study of the actual figures of the preceding months of 1900 and the corresponding months of 1899 and 1898 justifies an estimate which brings the exports to Porto Rico in the calendar year 1900 up to $5,400,000; to Cuba, $26,000,000; to the Philippines, $3,500,000; to the Hawaiian Islands, $15,000,000; and to the Samoan Islands and Guam, $200,000; making the grand total of $50,100,000 of exports to these islands in 1900, compared with $41,581,084 in 1899, $19,171,342 in 1898, and $16,922,305 in 1897. In every case our exports to these islands in the year 1900 will exceed those in preceding years. To Cuba the exports of the year will be double the average annual exports to that island except in the fiscal years 1892, 1893, and 1894, when the reciprocity treaty with Spain largely increased our sales to that island. To Porto Rico the exports of the year will be double those of any preceding year except 1899, and will exceed that year by 50 per cent. To the Hawaiian Islands, estimating figures of the closing

months of the year upon those of the earlier months and other obtainable data, the exports of the year are more than double those of any preceding year except 1899. To the Philippines the figures for 1900 will be double those of 1899 and more than ten times the highest figure in any earlier year. To the Samoan Islands the total will be double that of any preceding year. Comparing our exports to the islands above mentioned with those in the great reciprocity year 1893, when our exports to Cuba were double those of years immediately preceding the reciprocity act, it will be seen that our total in 1900 greatly exceeds that of the greatest of the reciprocity years. The total exports to Cuba, Porto Rico, and the Hawaiian and Philippine Islands in 1893 were $28,094,047, and, as above indicated, will in 1900 amount to $50,000,000 in round terms.

TRADE NOTES AND RECEIPTS.

Remedy for Warts.—As a simple and efficient remedy for the removal of warts, according to Daniel, formalin—a 40 per cent. formaldehyde solution—has been found valuable. For this purpose Daniel recommends to apply a wooden stick saturated with formalin and to press or rub the liquid firmly into the wart. The operation is said to be painless and only in case of cracks a temporary pain is said to be felt. After two or three applications (once daily) the wart shrivels up and drops off without leaving scars.—Monatschrift für Praktische Dermatologie.

Purification of Benzine.—If ill-smelling benzine is mixed with about 1 to 2 per cent. of its weight of free fatty acid, same will dissolve therein. Subsequently, about ¼ per cent. of tannin is added and all is mixed well. Finally, enough potash or soda lye, or even lime milk, is admixed until the fatty acids are saponified, and the tannic acid has become neutralized, shaking repeatedly. After a while the milky liquid separates into two layers, viz., a salty, soapy, mud-sediment and clear, colorless, and almost odorless benzine above.

This benzine, decanted and filtered, may be employed at once for many technical purposes, but gives an excellent, pure product upon a second distillation.

Fatty acid from tallow, olive oil, or other fats may be used, but care should be taken that same possess as slight an odor of rancid fat as possible. The so-called elaine or oleine—more correctly oleic acid—of the candle factories may likewise be employed, but same should first be agitated with a ½ per cent. soda solution to get rid of the bad-smelling fatty acids, especially the butyric acid.—Chemiker und Techniker Zeitung.

Production of Artificial Gems from Glass.—For a long time past efforts have been made to produce precious stones artificially. Seneca reports that a certain Demokritos imitated emeralds in an almost perfect manner, and Heraclius and Theophilus relate that in Italy the use of flint glass, for the imitation of artificial gems, was known at their times. In the Middle Ages especially the Jews were engaged in the manufacture of these stones. Subsequently, the employment of flint glass came more and more to the front, until finally, toward the close of the eighteenth century, the Vienna jeweler Joseph Strasser succeeded in finding a glass paste suitable for these purposes, which was later called strass after him. As regards its composition, strass constitutes a glass very rich in lead, which excels in great refractive power and a very high specific gravity. All artificial gems, indeed, possess an extraordinary brilliancy, but present the disadvantage of not withstanding wear for any length of time, owing to the glass rich in lead being too soft, a great drawback which will prevent a more general use of imitation stones.

Besides imitation stones there are also produced opaque glass pastes bearing the name of the stones they resemble, e. g., aventurine, azure-stone (lapis lazuli), chrysoprase, turquoise, obsidian, etc. For these, especially pure materials, as belonging to the most important ingredients of glassy bodies, are used and certain quantities of red lead and borax are still added.

The raw materials for the production of artificial gems are the finest silica and, as a rule, finely ground rock crystals; white sand and quartz, which remain pure white even at a higher temperature, may also be used.

Artificial borax is given the preference, since the native variety frequently contains substances which color the glass. Lead carbonate or red lead must be perfectly pure and not contain any protoxide, since the latter gives the glass a dull greenish hue. White lead and red lead have to dissolve completely in dilute nitric acid or without leaving a residue; the solution, neutralized as much as possible, must not be reddened by prussiate of potash. In the former case tin is present, in the latter copper. Arsenious acid and saltpeter must be perfectly pure and serve for the destruction of the organic substances. The materials without the coloring oxide furnish the starting quantity for the production of artificial gems; such glass pastes are named strass, as mentioned before.

The emerald, a precious stone of green color, is produced by melting 1,000 parts of strass and 8 parts of chromic oxide. Artificial emeralds are also obtained with cupric acid and ferric oxides, consisting of 43·84 grammes of rock crystal, 21·92 grammes of dry sodium carbonate, 7·2 grammes of calcined and powdered borax, 7·2 grammes of red lead, 3·65 grammes of saltpeter, 1·21 gramme of red ferric oxide and 0·6 gramme of green copper carbonate.

Agates are imitated by allowing fragments of variously colored pastes to flow together and stirring during the deliquation.

An amethyst is artificially produced by mixing 300 grammes of a glass frit with 0·6 gramme of gray manganese-ore, or from 300 grammes of frit containing 0·8 per cent. of manganic oxide, 36·5 grammes of saltpeter, 15 grammes of borax, and 15 grammes of minium (red lead). But a handsome amethyst is obtained by melting together 1,000 parts of strass, 8 parts of manganese oxide, 5 parts of cobalt oxide, and 2 parts of gold purple.

Latterly, attempts have also been made to produce very hard glasses for imitation stones from alumina and borax with the requisite coloring agents.—Die Edelmetall Industries.

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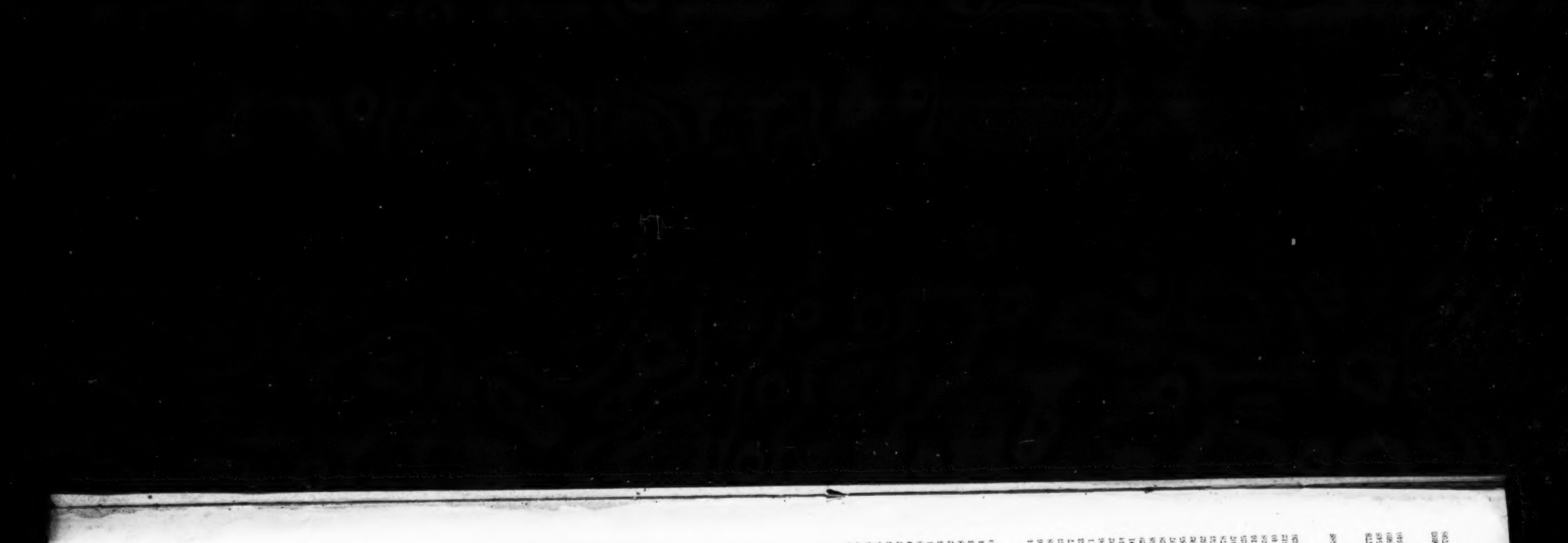
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